NOV 4 1924

Vol. XXIV No. 8 Whole No. 208

NOVEMBER, 1924

PERIODICAL ROOM GENERAL LIBRARY UNIV. OF MICH.

SCHOOL SCIENCE AND MATHEMATICS

A Journal for All Science and Mathematics Teachers

Founded by C. E. Linebergar

SMITH & TURTON, Publishers

Publication Office, Mount Morris, Illinois

CHICAGO OFFICE, 2055 East 72nd Place, CHICAGO, ILL.

CHARLES H. SMITH
EDITOR
The Hyde Park High School, Chicago

CHARLES M. TURTON
BUSINESS MANAGER
The Bowen High School, Chicago

DEPARTMENTAL EDITORS

Agriculture—Aretas W. Nolan
The University of Illinois, Urbana, Ill.

Astronomy—George W. Myers
The University of Chicago

Biology, Research in—Millard S. Markle
The Earlham College, Earlham, Indiana

Botany—Worralo Whitney
The Hyde Park High School, Chicago

Chemistry—Frank B. Wade
The Shortridge High School, Indianapolis, Ind.

Chemistry, Research in—B. S. Hopkins
The University of Illinois, Urbana, Ill.

Geography—William M. Gregory
The Normal Training School, Cleveland, Ohio

General Science—Fredric D. Barber
The State Normal University, Normal, Ill.

Mathematics—Jacob M. Kinney
The Crane Junior College, Chicago

Mathematics Problems—Joseph A. Nyberg
The Hyde Park High School, Chicago

Physics—Willis E. Tower
The Englewood Evening High School, Chicago

Physics, Research in—Homer L. Dodge
The State University of Oklahoma, at Norman, Representing American Physcial Society

Science Questions—Franklin T. Jones
The White Motor Co., Cleveland, Ohio

Zoology—Jerome Isenberger
The Crane Junior College, Chicago

Published monthly, October to June, Inclusive, at Mount Morris, Illinois
Price, $2.50 Per Year; 30 Cents Per Copy

Entered as second-class matter March 1, 1913, at the Post Office at Mount Morris, Illinois, under the Act of March 3, 1879

TURTOX PRODUCTS

FOR THE BIOLOGICAL SCIENCES

PRESERVED MATERIALS
For Zoology, Botany and Embryology

MICROSCOPE SLIDES
Over 1,000 different preparations

LANTERN SLIDES
Special sets, plain or colored

JEWELL MODELS
We are the sole manufacturers of these famous biological models

SKELETONS
Prepared and mounted in our own laboratories by expert osteologists

MUSEUM PREPARATIONS
Specially selected specimens in hermetically sealed museum jars

LIFE HISTORIES
Many of these are original preparations unobtainable elsewhere

Send to-day for your set of Turtox Catalogs

The Sign of the Turtox Pledges Absolute Satisfaction

GENERAL BIOLOGICAL SUPPLY HOUSE

1177-79 East 55th Street — Chicago, Ill.

JUST PUBLISHED

Industrial Geography

PRODUCTION—MANUFACTURE—COMMERCE

Author:
RAY HUGHES WHITBECK
Professor of Geography, University of Wisconsin

REFLECTS
EXISTING
CONDITIONS

AMERICAN BOOK COMPANY

NEW YORK
CINCINNATI
CHICAGO
BOSTON
ATLANTA

330 East 22nd Street

Chicago, Illinois

SCHOOL SCIENCE AND MATHEMATICS

VOL. XXIV, NO. 8. NOVEMBER, 1924 WHOLE NO. 208

MEASUREMENT OF THE RESULTS OF THE TEACHING OF CHEMISTRY.

BY HENRY L. GERRY,

Teachers College of the City of Boston

In a previous paper[1] we have indicated briefly some of the influences that have been effective in developing the sort of chemistry that is taught in the American secondary school today. In this article, we shall show some of the reasons why teachers' traditional methods of grading accomplishment in present day chemistry are objectionable. We shall also point out some of the superiorities of standard tests.

Probably there has always been some sort of measurement of the results of teaching. It is almost a universal trait that a workman judge the quality of the product of his toil. The teacher is but a workman employed in the moulding of human materials. That teachers were measuring the results of instruction four thousand years ago is pointed out by Ballard[2], who records the fact that there were competitive examinations in China as early as 2000 B. C. Doubtless ever since schools have been conducted one of the functions of the teacher has been a pronouncement of judgment upon the degree of success that each student has attained with his studies.

Until recently the final judgment that a teacher has made upon the accomplishment of his students has commonly been highly subjective. In general, judgment has been based upon the teacher's impressions of the value of the daily oral work of the pupil and upon the results of written examinations given from time to time. Both of these methods of weighing the products of class-room instruction are highly unscientific and subject to wide variation.

[1] School Science and Mathematics, 24: 457-466.
[2] Ballard, P. B., Mental Tests, p. 3.

In the oral quiz the teacher frequently participates to such an extent that he does not get a true impression of the pupil's knowledge of the topic. One of the faults of teachers, frequently pointed out, is that they talk too much when conducting an oral quiz. They confuse testing with teaching. In addition to the questions of the quiz they frequently give hints, offer suggestions, or ask leading questions until they have succeeded in wringing a "recitation" from the pupil. One teacher is said to have remarked that, if given sufficient time, he could make any student give a satisfactory recitation. When teachers do this they have to guess at the amount of help that has been given and at the value of the responses that have been made. At best, it is a practice that is subject to wide variations and that does not lend itself to accurate appraisal. One has only to see a stenographic report of a recitation, such as those contained in Miss Stevens' monograph,[3] to be impressed not only with the undue proportion of time used by the teacher but also with the difficulties that arise in reaching a fair judgment of the accomplishments of pupils. In many cases, the teacher contributes the most of the answer and the pupil's participation is in the supplying of an occasional word, or in agreement or disagreement with the teacher's statement. By mere chance, one-half of the pupil's *Yes-No* answers must be correct; but there are other important factors tending to raise the proportion of correct responses considerably above the fifty per cent. obtained by mere chance. In the first place, the teacher commonly gives aid and assistance to the student who is at all observing, by the form in which he states his question or by the inflection with which it is asked. Some teachers habitually phrase a question such as "Is potassium sulfate an acid, a base, or a salt?" to which only one of the three possible answers is correct, so as always to bring the correct answer to the last part of the question; others, to the first part. It is the wise student that knows the pecularities of his own teacher! Again, the facial expression of the teacher frequently reveals the answer to a pupil who watches his questioner intently. An extreme case of this sort was recently observed where the teacher was so anxious to secure correct responses to her questions that she framed the answers with her lips so that a student who was at all clever at lip-reading could not help give her a satisfactory response. In fact it almost seemed as though one with acute hearing could hear the responses to her own questions.

[3]Stevens, Romiett, The Question as a Measure of Efficiency in Instruction, Teachers College Contributions to Education, No. 48.

In addition to this factor of the teacher's over-participation, his judgment of the quality of the student's responses to the questions of an oral quiz is often warped by factors that have no direct relationship thereto. There is always the interaction of personalities upon one another. As in life outside the school, so in the class-room the teacher has a greater feeling of friendliness toward some individuals than toward others. Try as conscientiously as he may to be impartial and fair, the bonds of sympathy, which are stronger with one student than with another, influence his judgment of the quality of the work produced. Sometimes, in a period of overconscientiousness, he may even underrate the accomplishment of a student who exhibits traits that he especially admires. Then, too, a teacher's mark is more or less affected, unconsciously of course, by a student's physical appearance, by his neatness in person and in dress, or by any abnormalities with which he may be afflicted. One teacher may give a lame boy a higher rating than his achievement actually warrants simply because the lad has a physical handicap that prevents his moving about in the acquirement of information with as great ease and facility as his mates. Another teacher, annoyed by the sound of crutches, by the shuffling sound of a dragged foot, or by the resultant chronic tardiness at class may render a judgment less favorable than that given a pupil who makes responses of identically the same quality but who is not an annoying factor in the teacher's life. Most teachers will protest that they do not do these things. Consciously, they generally do not; but without being aware of it, they are influenced by a large sum-total of factors that are entirely foreign to achievement.

Again, the interest that a student manifests in the subject may have an effect upon the opinion that the teacher holds of his achievement. It makes no difference whether this interest be genuine or spurious so long as the teacher thinks it genuine. Many students, knowing this, use this means to improve their scholarship rating.

Closely allied to interest as a factor influencing the teacher's judgment is the student's attitude and class-room conduct. Recently there came to notice the cases of two students who had been disciplinary problems throughout the year. In June they were given by their chemistry teacher a mark that was below passing in their school. The last of the same month, both wrote the College Entrance Examination Board paper in chemistry, both passed it, and both were admitted to college. There is

probably little doubt that these students were failed by their teacher, not because they did not know enough chemistry to pass the course, but because the teacher's judgment of their attainments was warped by irrelevant factors.

Besides the oral quizzes, most teachers employ as an aid in forming their judgments of a student's accomplishment a written paper, either a test or an examination. Perhaps this gives a fairer measure of the pupil's knowledge of a subject, than does the oral quiz but as usually administered it is open to grave criticism. Doubtless the mark is less influenced by the student's personality than in the case of the oral quiz; but a written paper adds the factor of appearance. The amount of knowledge of a school subject possessed by a student, and his handwriting ability, are distinct things. One of the aims in the teaching of a given school subject may be improved neatness in written work. If so, it would be justifiable to judge the outcome of instruction, in part, by the degree of neatness exhibited in the examination paper. Unless one of the aims of the subject were an improved quality of handwriting, however, one would not be justified in saying that the quality of achievement was low simply because there was difficulty in reading what was written. Yet this bias in judgment, it is admitted by many, is a not infrequent situation.

There are several reasons why a written test, prepared by one teacher, may not be a good measuring instrument of the achievement of pupils. Some teachers do not think about the questions of a test that they are going to give until the class has assembled. Then they hurriedly write on the board the first questions that come to mind. Oftentimes this procedure results in an examination that bears no relation to the relative importance of the items that are supposed to be covered, and that is composed of questions so badly framed that their meaning is almost obscured. It is not difficult to find teacher's questions that can be interpreted only if one knows the kind of questions that he is in the habit of asking and the sort of answer that he expects to them. Furthermore, there is a tendency to ask five, eight, or ten questions and assign each a value of twenty, twelve and a half, or ten points as the case may be. Although teachers assign equal values to the questions of a test, in general they make no scientific attempt to equalize either the importance or the difficulty of the items embraced in each question.

In addition to the faults often found in a test prepared upon the judgment of a single person, there are difficulties in securing

a sound estimate of accomplishment when the answers to the usual form of test are read by one person. A teacher's standards are fickle. If he reads papers on different days he will not score them on the same basis. His judgment of quality is affected by a number of extraneous factors such as his physical condition and his emotional tone. Even were he to read no more than twenty-five hour-essays at a single sitting, his judgment of qualities of excellence at the beginning and at the end of the period would be quite different.

Recognizing that factors, such as have been enumerated, influence individual judgments of teachers, some schools have attempted to get a group judgment on the accomplishment of a pupil. At the Philadelphia Central High School, for example, each boy who studies chemistry comes under the instruction of three professors each half year; a lecturer, a quiz-master, and a laboratory instructor. Both the quiz-master and the laboratory instructor form independent judgments of the lad's accomplishment in the subject. If these are widely variant, there is a conference to determine, if possible, the cause; and to make a readjustment in judgment. During the second half-year, it is intended that each student of chemistry shall be instructed by other men than those who taught him in the first half-year; at least, that no student shall have the same quiz-master and the same laboratory instructor two half-years in succession. If the results of independent judgments of teachers in the second half-year are far different from one another or from the judgment of accomplishment in the first half-year, there is another conference. In this way, it is hoped that no teacher's erratic judgment may give a student credit for much more or much less than he has accomplished. In some respects, this is an improvement over a judgment by an individual. To a great degree this group judgment removes the influence of such factors as personal admiration, personal animosities, and other individual peculiarities. The group arrangement in effect at the Central High School at Philadelphia, however, puts no check upon the method of the oral quiz, upon the type of questions asked in a written examination, or upon the variations that creep into the judgment of the quality of the answers. In these respects, the judgment remains an average of individual subjective conclusions based upon impressions.

Such a system as that just described is not applicable outside large schools. In past years, some teachers of chemistry in small

schools have made use of examinations, like those of the College Entrance Examination Board[4] or of the New York Board of Regents,[5] in arriving at judgments of pupils' accomplishment. In general, they have employed these in two ways. In the first place, they have used for their own class tests questions from previous years in lieu of those that they would have framed themselves. By doing this they have had the benefit of the mature judgment of a group of specialists on the importance of topics for examination, and, in general, they have had questions so stated that the meaning was unmistakably clear. So far the situation was reasonably satisfactory. But when the answers were submitted, the teacher had to rely upon his own judgment of the quality of each. First he had to form an individual opinion of what a satisfactory response to the question should be; and second, he had to estimate how near the student had approached to the quality of response that he had individually determined to be satisfactory. Had the College Board[6] or its agents published answers to its questions that represented different degrees of merit in the eyes of the group of examiners, the isolated teacher would have had a valuable basis for comparison and would have had to rely less upon his own judgment of the quality of the answers.

In the second place, a few teachers make use of the College Board or Regents' questions by having their students try the examinations upon their first appearance. Of all the boys and girls in our high schools who study chemistry each year, only a comparatively small number take examinations such as these. In these cases the judgment upon the achievement as represented by the quality of the answers, is the result of a group agreement. In the instance of the College Board, the men who mark the papers first discuss the questions and the answers, then all pass judgment upon the quality of a few answers and discuss the reasons for variations in judgment, and finally agree upon values to be assigned to a series of answers of varying merit. Then, if a paper is graded just above or just below the passing mark, its value is estimated by another reader for a concurrence of judgment. The procedure of the Board of Regents, although different in its details, is comparable to that of the College Board in the matter of group judgment of results.

[4] College Entrance Examination Board, 431 West 117th St., New York.
[5] Regents of the University of the State of New York, Albany.
[6] The College Board papers are published by Ginn and Company, Boston.

Not all teachers are willing to accept the group judgment secured in this way, although the method probably leads to a fairer estimate of achievement than can be rendered by a single judge. In New York State, the results of the Regents' Examinations must be entered on school records as evidence of the degree of achievement in the subject. From the number of requests each year that papers be reviewed, it is clear that teachers are not convinced of the infallibility of the Regents' marks. As far as College Board results are concerned, it is true that a few teachers accept the results as a final judgment of accomplishment, and that others make careful comparisons between their own subjective marks and those of the College Board. In some cases they do this to criticize the marks of the Board or to explain their own, and in others so to adjust their judgment that, another year, their ratings will be more nearly equivalent to those of the examining board. In many cases, however, the results of the College Board do not affect the teachers' judgments that have been recorded in school offices before the College Board Examinations are given. For these reasons, the influence of these kinds of examinations in determining the judgment of teachers on the achievement of pupils is small indeed. For the most part, the teacher has judged a pupil's achievement in a school subject by the oral contributions that he has made to a dialog that is frequently monopolized by the teacher; and by his written replies to questions that oftentimes are not such as would be considered of importance by a group of experts and are so worded as to have significance only for those who have learned the idiosyncrasies of the teacher.

Within the past few years the attention of educators has been turned to a supplementary method of testing that gives a measure of achievement more accurately than that secured by the individual judgment of a teacher, even better than that of an examining board. Such a method is found in the standard test.

The modern movement for the development and use of standard tests in this country goes back to the early spelling researches of Rice in 1894-95. In England, as early as 1864, there was in use a *scale book* for measuring the achievements of pupils.[7] This contained the germ of some of the ideas now employed in tests, but was not reported in America until recently. The significance of Rice's pioneer work, as a means of accurate and scientific measurement of achievement, was not recog-

[7]Thorndike, E. L., Educational Measurements of Fifty Years Ago, J. Ed. Psych, 4: 552.

nized at the time that it was done; its value became apparent only after other similar work had been completed. In 1910, Thorndike published his Handwriting Scale.[8] This original research was followed by others, carried out by men and women who extended and refined the process of test making. One need only mention the spelling scale by Ayres[9] or that by Buckingham[10] or the Woody Arithmetic Scales[11] as examples of the work that has been cordially received and is now widely known.

The first standard tests of achievement were constructed to measure results in the tool subjects: writing, spelling, arithmetic, and reading. The reason for this is obvious. For some years there has been a fairly good agreement upon the elements of a tool subject that should be taught in a given grade; or at least fairly close concurrence in practice. This gave a uniform body of material from which could be selected the items for the test. Moreover, there were large numbers of children studying the fundamental subjects in the grades so that there could be little difficulty in securing a sufficient number of representative cases to make the investigation profitable. Furthermore, the teachers of the lower grades were ready to co-operate with special investigators or school officials. These factors, but especially the tangibleness and objectiveness of the results of tests in the tool subjects, led to the early development of standard tests in the mechanical subjects. The results of handwriting are both tangible and objective. A sample of handwriting may be placed beside other samples and its relative merit determined either by the judgment of a large number of experts or by the comparative lengths of time required to read equal amounts from different samples. Likewise a word is spelled correctly or it is not spelled correctly; the answer to an example in arithmetic is either right or wrong; a given passage is read with a given degree of understanding within a certain time or it is not. These are perfectly objective things that readily lend themselves to measurement.

A few years after tests in some of the fundamental subjects had been developed, other investigators turned their attention to the more complex and subjective studies of the elementary school where values of appreciation needed to be determined.

---

[8]Thorndike, E. L., Handwriting, Teachers College Record, 11:83-175.
[9]Ayres, Leonard P., A Measuring Scale for Ability in Spelling, Russell Sage Foundation.
[10]Buckingham, B. R., Spelling Ability, Teachers College Contributions to Education, No. 59.
[11]Woody, Clifford, Measurements of Some Achievements in Arithmetic, Teachers College Contributions to Education, No. 80.

Tests in history, geography, and literature were developed. Other workers, at about the same time, attacked the problem of constructing tests for high school subjects. As the first tests developed for the elementary school were founded upon the more mechanical elements of its curriculum, so the first high school tests were based on the mechanical aspects of such studies as algebra and geometry. Very recently there has been attempted the more difficult task of constructing tests for high school subjects the outcomes of which are less tangible and less agreed about.

All of this time and effort would not have been expended by school men had they not believed that standard tests possess certain very marked superiorities over the traditional examinations. Some of these superiorities have been hinted at in the discussion of the rating of achievement by teachers' judgments. These will be passed in brief review and others added to them in the following paragraphs.

The questions of a standard test are usually superior to those of the ordinary class-room examination. They are selected, in general, upon the judgment of a group. Average judgment is generally recognized as better than that of any individual, not alone in education but in other fields as well. Sometimes the items of a test are selected on the judgment of a group of specialists to whom the items are submitted; at other times on the judgment of the group of specialists, as expressed in their textbooks; or again, on the judgment of a representative group of children of appropriate age and school grade as determined by their actual performance. This sort of selection results in a test that is characterized by more important ideas, more reasonable demands upon the pupil, or both. The first is the usual result of selection by a group of specialists; the second, by a group of pupils. The questions of a standard examination are usually couched in more precise expressions than those phrased by the teacher for his own ordinary examination. Words having peculiar usages in different parts of the country are guarded against; statements with double meaning are avoided. In short, questions of an objective test show fewer idiosyncracies in content and in phraseology than do tests prepared by individuals.

Every maker of a standard test has given considerable thought to the general question of examinations. He has realized the need of questions that require reasoning as distinguished from those that test merely memory. Therefore, when the subject

matter of the test has permitted, he has tried to include questions that are not tests of a pupil's ability to memorize alone, but that are tests of power to handle similar materials.

Another superiority found in the question itself is in the novelty of its appearance or of its expression. Novelty stimulates interest, and interest leads to closer application and greater effort. In this way the standard test probably gets a closer measure of the student's achievement than does the traditional examination.

Furthermore, the mechanics of a standard test are much more simple than in the case of the ordinary examination. The student has only to underline or write a word or phrase, to put across in an appropriate place, or to do some other very simple task. He is able to give most of his time and attention to solving the problems presented by the test and has to spend but little in recording his responses. When the student's response consists only in underscoring one of several possible answers, in supplying a word or phrase, or in indicating whether a statement is true or false, the extent of the field that may be covered during a given examination period is greatly increased, or the time required to examine on a given section of the work is greatly reduced. This means that standard tests, in the same length of time as ordinary examinations, may be much more comprehensive; in a briefer space of time, equally comprehensive, and therefore more frequent. As a means of frequent examination they may supplement, or in part supplant, the oral quiz. By their use in this way all students may be tested more effectively in the same time that was ineffectually used to test a few. Thus, better and more complete testing may be done without encroaching on the time that should be devoted to teaching.

The standard test also saves time for the teacher. In the ordinary examination of the essay type whole paragraphs must be read to learn if the student has given a satisfactory answer to the question. In the standard test only certain marks, crossings, underlinings, or single words or phrases must be sought. Furthermore, in the standard test the responses are found in the same relative position on every paper so that after a little familiarity with the test, the teacher consumes no time in finding them. The answer paper to the ordinary examination must usually be read by a person trained in the subject; a standard examination may be scored by a clerk entirely without knowledge of the subject matter. The scoring by a clerk is frequently

made possible by providing a scoring key, a stencil, or some other device to facilitate the process. In case the teacher has to score his own papers a device of this sort makes the actual marking a mechanical process and thus, by speeding up the mechanics, saves time which the teacher may devote to the more profitable task of an analysis of responses and the diagnosis of difficulties.

Besides shortening the time required to determine the status of the examinees, the standard test, with the scoring device, makes possible a greater uniformity of grading than can be attained when the teacher's subjective judgment is the criterion against which excellencies and defects are measured. In general, the questions of a standard test are so constructed that the answers must be either wholly right or wholly wrong. The complication of partial credits does not arise. The correct responses are indicated by the key. The teacher or the scoring clerk has no alternatives, no opportunity for the exercise of personal prejudices, no occasion for the exercise of judgment. The scoring is highly objective, with the result that an answer paper is graded the same today as yesterday, the same at the end of a five hour period of marking as at the beginning.

This objectivity of the standard tests makes it possible to compare with quantitative exactitude the levels of attainment of two individuals or of two classes. Heretofore, teachers have used symbols in the rating of pupils that have meant, in general, *excellent*, *good*, *fair*, *poor*, and so on. But a fair pupil in one school might have been rated as poor in another; or even as poor by another teacher of the same subject in the same school. When the teacher reports that a lad succeeded with ten items of a particular objective test his degree of attainment is more closely defined than it would have been had the teacher rated him as *fair*. Other teachers, by consulting the test, can obtain a clear, objective idea of the level of attainment to which this pupil has climbed. The value of standard tests for purposes of such comparison is enhanced by published norms of attainment. These show what pupils of a given age or grade tend, on the average, to do with the items of the test. They give an instructor an average measure of achievement against which to compare the results of his own teaching. It must always be remembered that the statistical norm is not an objective to be sought but that it is a measure of mediocre performance which cuts the entire group into two numerically equal halves; those above the average and those below. By comparison of his own results with

the norm, a teacher may learn how his results compare with the average results obtained with a large number of pupils over a wide area.

Until the last few years, the teacher has prepared and marked examination papers and graded pupils upon his own judgment, unconcerned with the methods or results of other teachers of the same subject, with the same papers, or with the same children. When a pupil was transferred from one school to another, the teachers' marks that went with him meant practically nothing. Recently there has been an awakening among teachers; they have begun to question the representativness of their own examinations and the meaning of their marks when compared with those of other teachers. In part, this has resulted from work that was done with some of the first standard tests; and in part, it has eventuated in further work in the construction of objective examinations. These are recognized not to be without shortcomings; however, they are believed to have some very definite superiorities. It is contended that the questions of a standard test are more likely to be representative of the field of the examination than those chosen as a result of an individual's whim; that they are usually more clearly phrased than have been some of those of past years; that they secure a better performance from the student than do those with which he has become familiar by long contact; that they examine over a wider range in the time usually given to examinations than do those of the older form; that they conserve the time of the teacher in scoring; and that they give an objective score such that comparisons may be made between different classes, between different years, or between the stages of advancement of the same class. That this kind of test has a place among the tools of a chemistry teacher, it will be the purpose of a subsequent article to show.

FIDO'S ANTISEPTIC LICK.

Everybody has noticed how when faithful Fido returns home late, more or less damaged by chance encounters with "lowlife" curs up the alley, he puts in a good hour or so licking his wounds. Science has shown this to be an application of some of the most modern methods of antisepsis. An examination of the saliva of human beings or animals shows the presence of materials known as oxisases or peroxidases. These promote oxidation or slow burning of the tissues or other substances, including evil germs. When Fido licks his wounds he is merely applying the same medical technic that his master does when using the medicine cabinet. Not being able to get his antiseptics out of bottles, he merely used what Nature has provided for him.

CERTAIN DIFFERENCES BETWEEN TEXT-BOOK EARTHWORMS AND REAL EARTHWORMS.[1]

By FRANK SMITH,

University of Illinois, Urbana, Ill.

This paper deals with earthworms of two quite different kinds, those that are found out of doors, in which I have been interested in the past thirty years; and those that are found in text-books, in which I have become interested more recently. During the thirty years that I have been interested in the outdoor varieties I have spent considerable time in collecting species in various parts of the country and have examined a good many collections made by others. This has led to the discovery and description of several new species, not previously known and also has made clear that in almost any locality in the United States there are likely to be several species that may properly be called common. In most of the Northern and Eastern States, the most abundant forms in random collections brought into school rooms and laboratories would commonly include several species which are also very common in Europe, and they have been introduced wherever Europeans have settled and cultivated the soil for many years. Introduced of course unintentionally, they have thrived at the expense of indigenous forms and to some extent replaced them in the long cultivated areas. In the Northern tier of states most of the species belong to the family Lumbricidae, but include several different species of at least three different genera. In the latitude of Illinois and further South, representatives of other families of earthworms are abundant and in many cases include the largest of the specimens collected and anatomically they are very different from Lumbricidae. It is no more reasonable to talk about "the common earthworm" than it would be to talk about the common species of bird or the common kind of fish. It is done in 29 of 47 text-books recently examined.

My interest in the text-book varieties of earthworms has been recently increased as a result of a historical study of the development of our knowledge of Lumbricidae in general. *Lumbricus terrestris* which includes the largest fairly common species of northern Europe was the first species to be carefully and also carelessly described by European workers and naturally was the species adopted by text-book writers of England. Earlier American text-book authors have followed in their footsteps,

[1]From Illinois State Academy of Science Transactions, Vol. 17.

for the greater part, and this has been feasible since *L. terrestris*, or *L. herculeus* as it was formerly called, has become fairly abundant in our northern states and is supplied by dealers. In most cases this text-book *L. terrestris* is the one which was known a half century ago before the use of the serial section method of anatomical study. It is quite different in some respects from the outdoors *L. terrestris* as made known by more recent investigations, which very few of our text-book authors have consulted.

"The common earthworm" is a variety which is very frequently met with in more recent text-books, but not in collections. As described in a new textbook which appeared within the last year this variety would seem to be a hybrid form from ancestors belonging to two different genera of outdoor species and which has also acquired some additional characters found in none of them.

In so far as time will permit I wish to deal with three different topics, viz.: the calciferous glands; certain blood bessels in the anterior dozen somites; and the position of the nephridic pores; and will compare text-book statements with facts.

I have no disposition to criticize any teacher or writer who decides against the advisability of giving attention to the calciferous glands, but I do protest against the incorrect statements that are found in the text-books that make a pretense of giving information about them. We will first give attention to the calciferous glands of the extremely abundant species *Helodrilus caliginosus trapezoides.*

An essential feature is the peculiar modification in the structure of the wall of the esophagus in the somites 10 to 14. In these somites, the muscle layer of the wall becomes separated from the inner epithelial layer and the space between them is divided up into a series of longitudinal chambers which are separated by flattened lamellae that are radially arranged around the lumen of the esophagus. These chambers seem to end blindly at their posterior ends, which are in somite 14, or at the anterior margin of 15. As in most species commonly studied in the laboratories, the esophageal wall in somite 10 is evaginated into two lateral pouches one on each side, often called esophageal pouches which retain the communication between their cavities and the lumen of the esophagus. The longitudinal chambers with their separating lamellae extend into these pouches between the muscle and epthelial layers for a distance which varies in

the different species. Ultimately the cavities of the chambers open into the pouch cavities and a definite communication is established. In one species and in only one of those commonly studied, *Lumbricus terrestris*, in each of the two somites next posterior to the pouches there are paired lateral swellings of the chambered wall, which superficially resemble the pouches in somite 10 in size and form. This results in the presence of three pairs of lateral expansions of the esophageal tube which superficially resemble each other somewhat, and have led to the very common statements concerning three pairs of glands.

These paired inflations of the esophagus are in somite 10, 11, and 12. They are not separate glands, but are simply parts of one glandular structure, developed in the wall of the esophagus in somites 10 to 14. They certainly are not three pairs of pouches or diverticula opening into the esophagus as often stated. Marshall and Hurst's Zoology and a few other text-books that have adopted the statements contained in it are most nearly correct in their statements concerning the gland or glands, but make no mention of the continuation of the gland development in somites posterior to the 12th somite.

We will now consider some of the more common errors found in the text-book statements concerning this part of the worm. A new text-book which appeared in 1923 states that the esophagus begins in the "6th segment and continues posteriorly as a thin-walled, undifferentiated tube to the 14th segment where it connects with the crop and gizzard. Three pairs of calciferous glands open into the esophagus near its posterior end." We have seen that the so called glands are merely parts of a highly differentiated wall, and furthermore that instead of the three pairs alike opening into the esophagus only one pair has such direct openings. In this book, "The Common Earthworm" is described without any specific name, but the statement is made that the clitellum is on somites 28 to 35, from which it is evident that the author was writing about an earthworm altogether different from *Lumbricus terrestris*, in which the clitellum is on somites 32 to 37, and one in which there is but one pair of conspicuous enlargements of the esophagus instead of three pairs. The description of the reproductive organs, also applies to *L. terrestris* rather than to a worm with the clitellum on somites 28 to 35.

The statements in such text-books concerning the calciferous glands in earthworms are more than a century behind the times,

since they include less that is accurate and more that is inaccurate than is found in a paper by a European writer which appeared in 1820. I have recently examined 47 text-books in which earthworms are included in the list of animals studied. In 23 of them the calciferous glands are not discussed. Just 18 of the other 24 states, or imply, that the glands of the three pairs are alike. Only six mention differences of structure. Four give the correct location; five an incorrect location; and the other 15 are indefinite. Five of the 24 books describing the glands do not mention the number, and the other 19 all state that there are three pairs, even though the majority of them do not intimate that *L. terrestris* is the species of earthworm being discussed. The trouble is due to the fact that most authors do not base their statements on their own study of the animals nor on the published results of careful investigations, but chiefly on what they find in other text-books with an ancestry dating back into the previous century. A paper by Harrington in 1899 in the Journal of Morphology contained illustrations and information which supply a basis for correct statements concerning the anatomy of the glands in *L. terrestris*, but Hegner is the only author that seems to have made use of it, and he has incorporated in his account one rather serious error. The general facts of position and form can be easily seen in a preparation made by splitting a well hardened specimen with a razor blade, in a frontal plane, about on a level with the upper rows of seta bundles. Serial sections are necessary for a detailed study of the anatomy.

Another topic in which I have been interested includes the text-book statements concerning the location of the nephridiopores. The nephridia are paired excretory organs of which one pair is found in each of all the somites, except a few at the anterior and posterior ends of the worm. Internally their ducts enter the body wall quite uniformly at the anterior margin of their respective somites, and slightly dorsad of the rows of ventral seta bundles. Approximately one half of the ducts pass directly through the body wall and their external openings or nephridiopores are slightly dorsad of the rows of ventral seta bundles and hence on the surface of the ventral half of the worm. Since all the nephridial ducts enter the body well at about the same level it seems natural to expect them to open externally at about the same level, but on the contrary approximately one-half of the nephridial ducts follow a course in the body wall

which leads dorsal for some distance and they emerge at the surface dorsal of the row of dorsad set of bundles at irregular distances. Marshall and Hurst described the location correctly more than 30 years ago and explained how the irregularity might be readily shown by stripping off pieces of the cuticula from slightly macerated specimens and placing them on slides, a very simple operation. Of 24 text-books making statements, concerning the location of the nephridiopores, I find but three that have their statements correct. The others all assign a uniform location.

I will make brief reference to another feature of earthworm anatomy which is the occasion of numerous text-book errors. It involves a part of the circulatory system. The dorsal vessel, posterior to the so-called hearts of which the posterior pair is in the 11th somite, is a collecting vessel and receives blood from the body wall and from the alimentary tract through branches of the vascular system in each of most of the somites. This blood flows anteriorly and is forced into the ventral vessel by the hearts. In the anterior dozen somites the dorsal vessel does not function as a collecting vessel. The ventral vessel is in general a distributing vessel and from it blood is distributed to the body wall and alimentary tract. In it the blood flows anteriorly in front of the hearts and posteriorly throughout the remainder of the body. It is a very common assumption by text-book authors that the dorsal vessel functions as a collecting vessel throughout its whole extent which is not true. Two longitudinal vascular trunks lying one on each side of the alimentary canal, and joining the dorsal vessel at their posterior ends in the twelfth somite, act as the collecting vessels in the anterior somites in place of the dorsal vessel. Only seven of the text-books mentioned make any reference to these vessels and only one of them makes reference to the posterior connections of these vessels with the dorsal vessel in somite 12. Very few of the authors seem to have known of a very useful paper on circulation in earthworms which appeared in The American Naturalist in 1902 and was prepared by Johnston and Johnson.

NINE STATES REQUIRE BIBLE READING IN SCHOOLS.

Nine States now require that the Bible be read at stated times in the public schools, according to information recently compiled in the Bureau of Education. These States are Alabama, Delaware, Georgia, Kentucky, Maine, Massachusetts, New Jersey, Pennsylvania, and Tennessee. Three States, Maine, Delaware, and Kentucky, have passed Bible-reading laws since the publication of Bureau of Education Bulletin 1923 No. 15, in which six States were reported.

THE ASTRONOMY OF THE ATOM.

By Dr. Robert A. Millikan,

California Institute of Technology, Los Angeles, Calif.

The world is just entering upon a period of development of atomic mechanics, or of the astronomy of the atom, which has many points in common with the period of development of celestial mechanics which occupied the two or two and a half centuries following Galileo. Celestial mechanics was made possible through the invention of the telescope. The spectroscope bears precisely an analogous position with respect to atomic mechanics. The telescope made it possible to determine the exact orbits of heavenly bodies and to check by precise observation of such phenomena as the time of eclipses the theoretical results which are consequences of the Newtonian laws. Similarly, today the spectroscope has furnished the physicists with means for the quantitative testing of the recently developed laws of atomic mechanics, and it is today furnishing as exacting proof of the orbital theory of electronic motions as the telescope furnished a century earlier for the orbital theory of the motions of heavenly bodies.

The present paper shows not merely what kind of phenomena can be predicted with the aid of the orbital theory of electrons and atoms, but with what amazing precision these predictions are verified by the test of experiments. These results have been made possible because of the development of high vacuum "hot spark" spectrometry with the aid of which we were able first in 1920 to push three or four octaves farther into the ultraviolet than preceding investigators had gone. For the sake of simplicity, I shall at first confine attention to the radiations emitted by one particular atom, namely, the atom of boron, familiar to every household because of the abundant use of boracic acid for disinfecting purposes.

The atom of boron is the fifth in the order of increasing atomic weights, hydrogen being the lightest, helium the next, lithium the next, beryllium the next, and boron the next. This means that the nucleus of the boron atom contains five free positive electrons and that five negative electrons are held outside the nucleus, or just enough to make the normal boron atom electrically neutral. Of these five electrons, two have been proved heretofore, and are again proved in this paper, to be close to the nucleus. The remaining three are four or five times more remote from the nucleus and are called its valence electrons.

For the sake of later comparison it is useful to recall that lithium possesses one of these valence electrons, beryllium, two, boron three, carbon four, nitrogen five, oxygen six, and fluorin seven, which is the highest number possessed by any known atom having the possibility of combining with other atoms at all.

Now the interesting property of our hot sparks, which are very high potential discharges in the highest vacua between electrodes from a fraction of a millimeter up to one or two millimeters apart, is that such hot sparks possess an extraordinary ionizing power. Mr. I. S. Bowen and myself at the California Institute of Technology have recently definitely proved that these hot sparks have the power of stripping a great many atoms completely of all their valence or outer electrons. These stripped atoms of lithium, beryllium, boron, carbon, and nitrogen, for example, are then completely similar atomic structures, save for the fact that the central charge increases in the ratios one, two, three, four, five in going from lithium to nitrogen. This is the first time that it has become possible to compare the radiating properties of such a long series of similar atomic structures and the discovery of a means of obtaining such a series has furnished the opportunity of getting some very interesting checks upon the theory of electronic orbits.

Now the theory of electronic orbits in atoms is similar to the theory of planetary orbits in astronomy save that the atoms have one restriction unknown to the former. While celestial mechanics permits of the existence of as many orbits as you please around a given central sun, atomic mechanics permits of a very limited number of orbits whose radii progress (in the simple Bohr theory) in the ratio of the squares of the numbers one, two, three, four, five, etc. Atomic mechanics also differs from celestial mechanics in the mechanism by which the existence of a particular orbit can be experimentally tested. Thus, the most exact test which astronomy offers for the correctness of hypothetical planetary orbits is the prediction of the instant of passage of two such orbits through a given line so as to produce an eclipse. If the eclipse occurs at the predicted instant, it is considered that the theory which made the predictions possible has received extraordinary quantitative support. In the astronomy of the atom, on the other hand, we cannot observe an eclipse but what we do observe is the frequency (the reciprocal of the wave-length) of the radiation emitted when an electron jumps from one of its possible orbits to another.

These jumps always occur from the orbits more remote from the nucleus to those which are closer to it and the difference in the energies of the electrons in the two orbits (which I shall call the energy of the orbit itself) is found to be in every case exactly proportional to the frequency emitted. It is this frequency which the spectroscope immediately brings to light as a spectral line whose wave length, and therefore whose frequency, it enables us very accurately to measure.

The whole number of different orbits which are possible in such a simple nucleus-electron-system as is furnished by the hydrogen atom has long been accurately known experimentally, and these known orbits have been fitted beautifully and accurately into what is known as the simple Bohr theory.

This theory requires that if the charge on the nucleus should be successively given the values one, two, three, four, five, the frequencies of all of the orbits would be increased in the ratios one, four, nine, sixteen, twenty-five. Now the discovery of the possibility of stripping all the valence electrons off the atoms of lithium, beryllium, boron, carbon, and nitrogen has given us the means of comparing the radiations from what are in effect simple nucleus-electron-systems in which the charge on the nucleus increases in the ratios one, two, three, four, five, provided always that we are comparing orbits in different atoms which are so remote from the nucleus that the pair of electrons which, as indicated above, is near the nucleus in all the atoms may be considered as exerting their forces as though they were in the nucleus itself.

To return now to the consideration of the stripped boron atom. When Mr. Bowen and I began to get evidence that our hot sparks were stripping the boron atoms of all their valence electrons we set to work to predict exactly what sort of frequencies (or of wave lengths) we might expect to be emitted by the stripped boron atoms as a single electron, in being drawn into this stripped atom, began to jump between the possible orbits which ought to exist about it. Thus, on the basis of our knowledge of the spectral lines emitted by hydrogen, we predicted at once that an electron in jumping from the fifth to the fourth of these possible orbits would produce a line of just nine times the frequency of the radiation produced when the hydrogen atom electron jumped from the fifth to the fourth orbit. We computed in this way that this stripped boron atom ought to have a line whose wave length was 4500 Angstrom units,

that is, a line in the blue region of the ordinary visible spectrum. No such line had ever been observed with boron thus far, but no one had before worked with light like that given off by our hot sparks which one could expect would produce stripped boron atoms. So we made our exposure, developed our plate, and found our predicted line which no one had ever seen before at exactly the wave length 4499.0, or within one part in 5000 of the predicted spot. In other words, our predicted "eclipse" in the field of astronomical orbits had occurred at exactly the right time.

We also computed the radiation that would be produced when the electron circling around the stripped boron atom fell from the third orbit to the second and got 678 angstroms. We looked up our table of boron lines in the extreme ultra-violet which we had published last January and found that we had recorded a strong line at wave length 677 angstroms, but if this were indeed due to the stripped boron atom it ought to be, like the so-called D line of sodium, a doublet, that is, a pair of lines very close together. It had not appeared so on our old plate, but the spectrograph had not been one which could have separated this pair, even if it existed, so we built a new spectrograph of higher resolving power and took another photograph of this line and found that it was indeed a doublet just as our orbit theory demanded, the two components of which had wave lengths of 677.01 and 677.16.

We have now brought to light all of the lines which were to be expected from the stripped boron atom and by checking all of these predictions by experiment we had proved with absolute certainty that in our hot sparks we were producing stripped boron atoms.

But someone says: Are these results dependent upon your orbit theory of the motion of electrons? Thus far, not completely, but in the next stage they are completely so dependent. I have spoken of the doublets which we found produced by the stripped boron atom. Now the principal lines in the spectrum of hydrogen are also doublets and a beautiful theory was developed by Professor Sommerfeld for explaining these doublets. He showed that there ought to be two orbits, one circular and one elliptical, which would have exactly the same energy if it were not for the fact that the mass of the electrons in the elliptical orbit should grow greater as its speed increased in going through perihelion and smaller as it went through aphelion,

and that because of the dependence of mass upon speed which is required by the Einstein theory of relativity. He further computed exactly with the aid of that theory the differences in the energies of two orbits, the one circular and the other elliptical, and found that this theory, which yielded a formula in which there were no undetermined constants at all, predicted completely and exactly the observed frequency separation of the hydrogen doublet. We now tried this relativity doublet theory upon the doublets which we had found in lithium, beryllium, boron, and carbon, and found that this purely theoretical formula predicted exactly the observed separations in all cases. We then predicted from this formula the separation of the doublet which ought to be produced by the stripped nitrogen atom and looking in the nitrogen spectrum found a nitrogen doublet with precisely the correct separation and at a wave length which we could also predict by our theory. We had thus brought to light a most powerful instrument with which we can now analyze the light that comes from any kind of a source, for example, a very hot star, and know at once by comparison with the theory of observed lines whether stripped atoms of a whole series of substances exist or do not exist in the sources. In this way, we have definitely proved the existence in our hot sparks of stripped atoms of lithium, silicon, phosphorus, and sulphur, this last atom having been stripped of six valence electrons, phosphorus of five, silicon of four, aluminum of three, magnesium of two, and sodium of one.

These methods bring to light new ways of going on eclipse expeditions in the study of the astronomy of the sub-atomic world and they reveal new possibilities for the reading of the conditions existing in the stars. Truly, we are just now entering upon a period of the fascinating study of the astronomy of the atom, a period in which the spectroscope is the instrument with which we must bring to light wonders no less fascinating than those which the telescope has revealed in the study of the stars. —*Science Service.*

MORE CALIFORNIA SCHOOLS TAKING UP BIOLOGY.

Biology, according to a study of science in California reported in the University High School Journal, has made rapid development in that State within the past few years. In 1907-8 biology appeared in only two high schools. In 1922-23 it was given in 59.5 per cent of the schools and is still on the increase. General science, more evenly distributed than any other science except physics and chemistry, appears in 96.4 per cent of schools with an enrollment of 1,000 or over.—*School Life.*

THE STATUS OF LABORATORY WORK IN THE HIGH SCHOOLS OF THE COUNTRY.

W. G. Bowers and A. E. Brown,

State Teachers College, Greeley, Colo.

The Development of Laboratory Work.

It goes without saying that laboratory work in connection with the study of chemistry dates as far back as any phase of the study. The use of the laboratory to the college student, however, does not date back very far. The custom came very slowly at first and most of the developments have come in the last thirty years. The use of the laboratory to high school students has come by more recent and rapid developments.

Robert H. Bradbury, School Science and Math., 11: 802, (1911) points to the fact that the great chemist Liebig, at Giessen, was the first to offer a laboratory to chemistry students. This was about one hundred years ago.

About that same time in this country the academy was the prevailing secondary school. To show the importance of chemistry in those academies and to show that laboratory work was a reputable adjunct, we refer to S. R. Powers, Research Publications of the University of Minnesota, No. 13 (1920) and find that sixteen academies in North Carolina, five in Massachusetts, four in Connecticut, and ten in New York offered chemistry and some of these in their announcements set forth the claim that they had apparatus to illustrate the lessons in Philosophy and Chemistry.

According to The History of Central High School of Philadelphia, the building erected in 1854 installed a chemical laboratory. About the same time, as related by W. H. Wells, American Journal of Education, 3: 531, a laboratory was installed in the first high school building erected in Chicago. And according to J. H. Tice, American Journal of Education 1:353, the first high school building in St. Louis was provided with a chemical laboratory.

We would not necessarily assume from these items of history that students were allowed to work regularly in these laboratories. Bradbury, School Science and Math., 11:802, (1911) says that the high school laboratory is a new institution, not more than thirty or forty years old. And in 1911 Bradbury called the high school laboratory a meagerly equipped institution.

E. R. Downing, School Review 25:646, (1917), in remarking about Liebig's laboratory of 1824 says that only advanced

students who showed exceptional ability were allowed to carry on experiments in the laboratory. So we could hardly call this the beginning of laboratory work for college students. Downing refers also to the fact that Harvard University offered its first laboratory to college students in 1846. So we might be justified in taking this as about the time when laboratory work had its beginning among college students in America. Then the same author assures us that laboratory work for students had its beginning in the high schools not less than fifty years later. This would place the inception of laboratory work for students in the high schools about thirty years ago, or about 1890. If we should estimate that high school laboratory work had its beginning in 1886, when Harvard University took the lead in making laboratory instruction a college entrance requirement, we would place this back only four years earlier.

The Reason for Such Conditions

To show with what difficulty the idea of laboratory instruction took hold in its first years of development, we need only to refer to B. S. Hopkins, School Science and Math., 19:295, where he tells the story of the young man who was called to the chair of chemistry in one of the eastern universities in 1872. This young professor possessed to a remarkable degree the ability to interest his students. One of his students becoming fascinated asked him for the privilege of working in the laboratory. So unusual was the request that it had to be referred to the faculty. But after due deliberation on the part of the faculty, it was decided that it would not be feasible to grant such a request because the young man would quite certainly break some valuable apparatus and use up some costly chemicals. Hopkins tells us also that there were only six universities at that time which would allow students in their laboratories.

Dr. Charles Eliot, School Science and Math., 6:703 says he was the first student of Harvard University to obtain the privilege of working in the laboratory and this was because Professor J. P. Cook fitted a laboratory in the basement of the university hall at his own expense. Dr. Eliot says also that such was the situation in the colleges at that time.

It is needless to say that the rare value of apparatus and the extreme cost of materials had much to do with these conditions, but the lack of standards in colleges and high schools and the lack of qualification on the part of teachers very likely impeded progress at first. Rufus P. Williams, Science 18: 330, (1903)

points out that the colleges were not standardized as to requirements. A few required laboratory instruction as entrance requirements, many did not. He says that at first the high schools made their own courses to suit conditions, the main condition being college entrance requirements, and that different colleges had different requirements, also that different conditions prevailed in different localities. So a babel of courses was the result.

Then too, an idea like the institution of laboratory work among beginning students always meets with the disapproval or the hesitancy at least, of conservative educators. It might be noticed in a series of previous articles of our own on the importance of laboratory work that most writers on the subject from 1900 to 1910 have a sort of condemnation for laboratory work. Most writers from 1910 to 1915 have a sort of attitude of being willing to try some things out and wait for results on some other phases of the problem. It will be found that not until the last five to seven years were the majority of educators willing to concede that laboratory instruction is of considerable value in the study of any science.

All of these conditions, and especially the latter, have been responsible for the very slow development of laboratory instruction.

Forces in Operation to Solve the Problem

At the present time many forces are at work to solve the difficulties. A few years ago the eastern colleges and high schools began to meet in conferences to try to get together on common grounds to unify and standardize requirements and establish foundations for courses, etc. Later they were followed by the western colleges and high schools, so that now conditions are favorable for the solution of the problems as to how much and what sort of laboratory work should be done in the high school and the college courses and how it should be carried on and how related to the text book work, etc.

The Present Compared to the Past

A few items taken from the situation in some of the leading states about the time of the greatest difficulties and some data from the situation at present will serve to show the growth as well as to give us the information that we ought to have concerning the status of laboratory instruction as it is at the present time.

Lyman C. Newell, School Review 9; 286, (1901), in discussing

the relative place and time for laboratory work brings out the fact that in Massachusetts in 1901, in forty-six high schools only twenty had double periods on any day during the week for laboratory work. Massachusetts was at that time the leading state in educational affairs.

W. C. Geer, School Review 14:275, (1906) gives in comparative manner the status of laboratory work in the state of New York and several other states in 1906. He obtained his data from a study of the notebooks turned in by the students entering Cornell University. These notebooks were made not for exhibition but to show the amount and character of work done by the students and teachers of the high schools.

These notebooks showed that various standards of requirements had their influence. First the report of the *Committee of Nine*, (University of the State of New York, High School Bulletin 7, 1900, page 714), stated that the laboratory work should comprise at least 108 hours all told. Second, The College Entrance Examination Board, Document No. 20 (1904) places the lower limit of laboratory work at 40 exercises. Also the syllabus of 1905, New York State Education Department, Secondary Education, Bulletin 27: (1905) expects of the teachers, laboratory work consisting of exercises requiring 30 double periods.

Geer says that at that time in spite of all the requirements and stipulations, 36.7% of the public schools of New York conducted their laboratory work in 45 minute periods, while only 30.4% used the double periods. He also states that in the schools outside of the state of New York 31.6% of the public schools used 45 minute period and 26.3% used the double periods. Of all the schools represented, those outside of New York as well as those in the state 41% used less than double periods.

In Geer's observation the majority of the schools of the different states favored two or three single periods per week in the laboratory He found that in 15.2% of all the schools only one single laboratory period per week was used, and that very few schools favored more than three single periods per week.

Geer also observed that in New York state 54.4% of the schools spent less than 100 hours on laboratory work. Outside of New York state 46.1% spent less than 100 hours. In New York state 30.7% of all of the schools both public and private, used more than 101 hours and less than 150 hours. Outside of New York 37.1% of all of the schools used over 101 hours and less than 150.

In order to study the conditions of the present as compared

with the condition of the time when Geer made his study, we are tabulating our data on the same plan as that used by Geer as much as possible. Our first aim is to compare conditions regarding double and single laboratory periods. Since Geer gives in percentages the schools using double periods and those using single periods, we are constructing our first table on that basis.

States	% Schools using two or more double periods per week	% Schools using one double period per week	% Schools using two or more single periods per week	% Schools using one single period per week
Arizona	100.	.....	.....	.....
California	85.7	.....	.....	.....
Colorado	70.	.....	20.	.....
Idaho	100.	.....	.....	.....
Illinois	80.2	6.6	6.6	6.6
Indiana	81.8	.....	9.1	.....
Iowa	90.	10.	.....	.....
Kansas	75.	.....	12.5	.....
Minnesota	75.	.....	12.5	.....
Missouri	100.	.....	.....	.....
Montana	100.	.....	.....	.....
Nebraska	100.	.....	.....	.....
North Dakota	75.	.....	12.5	12.5
New York	15.	75.	10.	.....
Ohio	88.	.....	5.5	5.5
Pennsylvania	55.	.....	45.	.....
South Dakota	70.	.....	30.	.....
Washington	80.	.....	20.	.....
Wisconsin	100.	.....	.....	.....
Wyoming	100.	.....	.....	.....
All States	82.3	4.5	9.4	1.2

While a good deal of concern has been exercised as to whether laboratory work should be given double or single periods, in our own opinions not a great deal of importance should be attached to this question of time. However, there are several fundamental exercises which could not be done at all if the time had to be divided into single periods. Since the most important time consideration is the total number of hours during the entire year we are showing that in the following table, and showing it in the same manner in which Geer showed his.

Our aim in the following table is to study comparatively the number of schools giving certain numbers of experiments or exercises. Regardless of how interesting it might be to show the number of schools in each state giving the different numbers of exercises from thirty up to ninety, we hardly feel justified in taking up that much space. So we have designed the table to show the percentage of schools giving numbers in certain units.

States	% Schools using more than 101 hours	% Schools using less than 100 hours	% Schools using more time than in text	% Schools using less time than in text
Arizona	100.	.....	100.	.....
California	100.	.....	80.	20.
Colorado	70.	15.	70.	15.
Idaho	100.	.....	100.	.....
Illinois	87.1	6.6	75.	12.5
Indiana	60.	30.	50.	20.
Iowa	80.	20.	60.	20.
Kansas	62.5	25.	50.	37.5
Minnesota	66.7	8.3	58.3	33.3
Missouri	83.3	16.6	100.	.....
Montana	100.	.....	100.	.....
Nebraska	85.8	14.2	85.8	14.2
North Dakota	71.5	28.5	57.2	28.5
New York	15.	85.	15.	85.
Ohio	66.	11.	83.	17.
Pennsylvania	55.	45.	45.	55.
South Dakota	70.	30.	70.	30.
Washington	60.	40.	60.	40.
Wisconsin	100.	.....	83.5	.....
Wyoming	100.	.....	75.	.....
All States	76.6	18.7	70.8	21.4

States	Experiments numbering 30–50	Experiments numbering 50–60	Experiments numbering 60–75	Experiments numbering 75–Ind.
Arizona	.....	.....	20.	80.
California	.....	.....	.....	50.
Colorado	20.	25.	15.	30.
Idaho	25.	25.	.....	25.
Illinois	12.4	12.4	37.2	18.6
Indiana	8.3	8.3	41.5	33.2
Iowa	25.	12.5	37.5	12.5
Kansas	37.5	.....	12.5	25.
Minnesota	16.7	25.	33.3	16.7
Missouri	.....	50.	50.	.....
Montana	14.3	14.3	.....	71.4
Nebraska	.....	.....	.....	100.
North Dakota	12.5	25.	50.	12.5
New York	50.	14.	14.	22.
Ohio	16.7	25.	33.3	25.
Pennsylvania	11.	55.	11.	11.
South Dakota	66.7	33.3	.....	.....
Washington	.....	.....	.....	100.
Wisconsin	50.	.....	33.3	16.7
Wyoming	.....	.....	25.	75.

Not because we can make any comparisons with previous records as to special regulations, but because we consider it of interest to note some things in this respect, we have gathered from our data and noted some facts as follows.

13% of the schools in all of the states devote all of their time to general experiments.

30% of schools in all of the states devote from 5%-15% of their time to strictly qualitative work according to a set scheme.

8% of the schools in all of the states devote 15-25% of their time to qualitative experiments.

45% of the schools in all of the states devote 5-15% of their time to quantitative experiments.

4.5% of all the schools in all states have no regulations as to time or number of experiments but go into the laboratory when they see fit and back to class room when they see fit.

4.5% of the schools in all states regulate time and number of experiments to suit textbook and pay no attention to manual or regularity in laboratory work.

8% of the schools in all states have regulated as to time but not as to number of experiments.

2.5% of the schools in all states regulated as to number but not as to time for experiments.

89.5% of the schools in all states regulate as to both time and number of experiments.

1.5% of the schools required 2 single periods which were 75-80 minutes each.

1% of the schools required one double and one single period.

0.5% of the schools give three single periods, two for students and one for demonstrations by the instructor.

15% of the schools give as many double periods to laboratory as they do single periods to textbook work.

Observations and Conclusions

Without summarizing or calling attention to many points which tell their own story we offer the following comments. Our questionnaires for the present investigation covered many more points than the time given to laboratory work, but in order to give an idea of the developments, we are giving the time condition in laboratory work now, as obtained from 250 of the representative schools of the country, compared with the time condition in 1906. At the present time 10.6% of the schools give single periods, and 86.8% give double periods. 18.7% give less than 100 hours and 76.6% give more than 100 hours. This means 50.3% more of the schools are giving double periods, or 200% increase based on the 26.3% using double periods in 1906, and 40% more giving more than 100 hours, or more than 100% increase on the 37.1% using more than 100 hours. This shows how rapidly the laboratory idea has grown.

It might be interesting to note from the foregoing table that as far as time devoted to laboratory work and number of exercises done, that the state of New York, the leading state in the 1906 investigation there has been no growth since 1906. The low percentage of schools in that state using more than 100 hours per year lowers the figures expressing the growth in the states taken as a whole. It will be noticed while Pennsylvania and Ohio having only 55 and 66% of their schools using more than 100 hours in the laboratory that this is a large percentage compared to the 15% in New York. The percentages which bring the whole number up are found in the western states. The states having 100% of the schools using more than 100 hours are in the far west.

We observed in our list of special notes that 4.5% of all the schools regulate laboratory work to suit the text and follow no manual or fixed list. This means, of course, no fixed time or number of experiments in laboratory work. Some good authorities like Professor Newell, advocate this method, but evidently conditions in most of the schools are not such as to afford it its best advantages.

A splendid indication is seen in the fact that nine-tenths of the schools regulate as to both time and number of experiments. The eight per cent, regulating as to time only indicates that time is likely to be wasted if that is the only regulating influence. The two and one-half per cent. going on numbers only shows that character of work must be habitually slighted, and that a stronger influence should be brought to bear.

The developments shown in the foregoing comparison may be considered rapid or not according to our consideration of what had preceded and what may follow. When we consider that about as much time in the history of high school chemistry, preceded the introduction of laboratory work as has elapsed since that time, and that now three-fourths of the high schools are using two double periods per week and more than one hundred hours per year in laboratory work, and that nearly three-fourths of them are using more real scheduled time in the laboratory than in the text books; we are inclined to conclude that the developments have been rapid. When we think of the conditions in the conservative states of New York, Pennsylvania, and Ohio, we should say perhaps too rapid.

THE VALUE OF SURVEYS IN BIOLOGICAL SCIENCE.

By GEORGE W. HUNTER.
Knox College, Galesburg, Ill.

A good many years ago when the writer was a young teacher in The Hyde Park High School of Chicago he paid a visit to the classes of a man who at that time was one of the most finished teachers of Zoology in the city of Chicago. I refer to Herbert E. Walter, now a professor at Brown University, Providence, R. I. I well remember my surprise when Dr. Walter led the way with his class to a vacant area close to the school and then, in the environmental conditions afforded by a weed grown sandy Chicago lot, I saw some of the best zoological work done by teachers and students that it has ever been my good fortune to observe.

Right then and there I registered a vow that I would introduce field work into my courses. And right then and there incidentally I began to see the value of biological surveys—surveys of a sort that would interpret the immediate biological environment of the student to him as an individual.

But a very considerable change has come in my attitude toward the kind of work to be attempted in elementary biological courses. I should like to explain what I mean by the term "survey" and to illustrate with some practical examples the type of work that the average teacher can attempt in the secondary school or college.

It has become the custom nowadays to speak in terms of measurements and statistics, not the old fashioned statistics which were capable of being twisted and subverted, but statistics collected from reliable sources and used comparatively and with a standardized basis for comparison. It is a part of the educational courses in every university today and it is equally a part of the education of everyone so to be able to understand how such facts are gathered and how to interpret them after they are collected. The making and interpreting of graphs should be a part of the course in any elementary science and biological science is no exception to the rule.

What better or more reliable source of statistics are there than those published weekly in the United States Public Health Reports issued by the United States Public Health Service. Every teacher in biology should have these reports sent to his school and make use of the contained material in working out statistical problems with reference to the relation of climate and

environment to certain types of disease, seasonal variation of certain diseases, the comparative case rate and death rate of a number of different germ diseases, a comparison of the toll demanded by old age as against certain germ diseases, the gradually decreasing death rate from tuberculosis, the gradually increasing death rate from cancer, heart and nervous and other diseases. The list of problems might be extended almost indefinitely. Such a wealth of material is found in this very easily obtained weekly bulletin.

From this type of work it is only a step to the individual making his own statistical reports as obtained from sanitary surveys. Such a piece of work lends itself to a wide awake biology teacher and an interested class as the most worth while practical culmination of a biology course. Here work can be done of a practical sort which may mean an awakened civic conscience as well as a field for projects in public health and sanitation for the biology class.

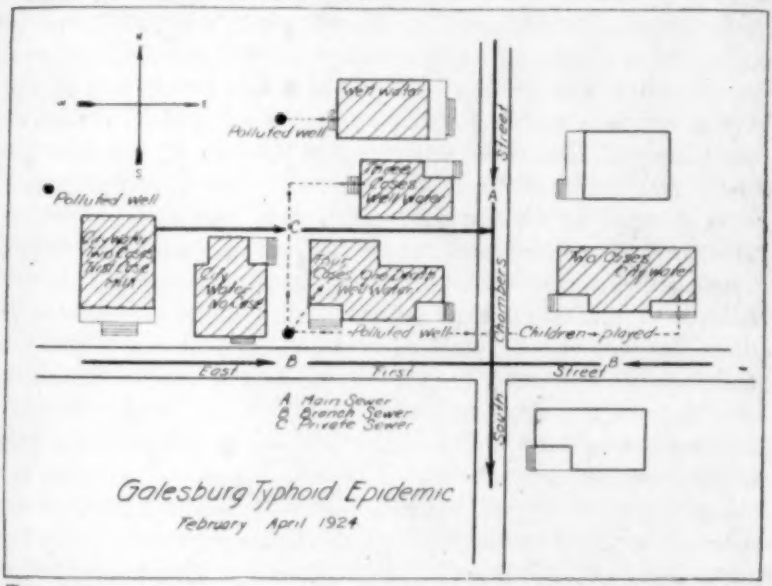
Here, as in all science work, measurements or comparisons must be determined. For this purpose score cards must be worked out. These are evaluations in which arbitrary measurements of weights agreed upon in class conference are used to compare according to a fixed scale the environmental conditions found in the area surveyed. These score cards might be used, for example, in determining comparative housing conditions, the sanitary conditions of food stores, factories and hotels. The scoring of hygienic conditions of movie houses, churches and homes is also an important item. Score cards are now used by those in public surveys to determine the conditions of milk and water supplies and of the sanitary condition of schools and other public buildings.

Sanitary surveys demand a study by the pupils making the survey of the local topography, climate, soil, drainage and water supplies, it requires the student to look into local means for safeguarding the water, milk and food supplies. It means an intensive study of the city health machinery and usually results in the knowledge on the part of the student of the deplorable lack of funds allotted for public health protection. It involves the study of sewage and garbage disposal, of local and state and country wide food inspection, of factory and housing conditions. It points out to the future citizen the strong and weak points in his community and makes him realize through the class room discussions which are bound to rise from his findings, that after

all, biology and hygiene are very intimately applicable to his own daily life activities.

An example of how sanitary surveys may be of value in a community is seen by reference to the work done by a class in Public Health at Knox College in connection with a recent outbreak of typhoid that occurred in Galesburg, Illinois, in March and April, 1924.

On February 21st, a case of what was reported to be streptococcus infection occurred in a house on First Street, three doors from the corner of First and South Chambers Street. A child was quite ill but gradually recovered, the mother nursing it and later coming down with what appeared to be the same disease. The father not satisfied that the disease had been diagnosed properly called in another physician who made the Widal test and found that both mother and child had typhoid. About two weeks after the mother's illness, cases of typhoid began to develop in three houses, one located at the northwest corner of Chambers and First where four cases and one death occurred; three cases occurring at the house just north of the first on Chambers and two cases occurring in a house at the northeast corner of Chambers and First.



THE OUTBREAK OCCURRED IN A HOME THAT USED CITY DEEP WELL WATER. A CHILD PROBABLY CONTRACTED THE DISEASE THROUGH MILK OR A CARRIER. THE MOTHER NURSED THE CHILD AND TOOK THE DISEASE. ABOUT TWO WEEKS LATER THERE WAS A SERIOUS OUTBREAK, NINE CASES AND ONE DEATH OCCURRING IN THREE HOUSES SHOWN IN THE DIAGRAM. IN ALL CASES THE SOURCE APPEARED TO BE THE WELL AT THE CORNER OF CHAMBERS AND FIRST STREET.

Upon the outbreak, as I understand it, the City and State Health Department inspected the water of the well in the yard of the house at the northwest corner of First and Chambers streets. The findings of the State Board of Health showed pollution of this well and essentially the same findings as are reported in the following pages. But for some reason, probably because of inadequate machinery of the local health department, the facts were so obscured that the *public* did not understand them.

About two weeks after the outbreak, on looking over the map of the city made by the Public Health class of the previous year and realizing that this was a district of possible pollution by wells from outdoor toilets, I had the members of the class go out to that district and survey the district intensively. The following were the findings: not only was the well at the corner of East First and South Chambers polluted with intestinal bacteria but also other wells in the neighborhood were polluted. A further survey disclosed the fact that although there was a new sewer through East First Street, the city sewers in South Chambers and east of Chambers on First were old and when tapped all house sewers had been found to be clogged with dirt and debris. Furthermore, a private sewer was discovered to run from the house where the first case appeared to the Chambers Steeet sewer, passing within between 20 and 30 feet of the well which was so badly polluted and from which families at the corner of East First and South Chambers Street and the house just north of them drank. Still further investigation showed that in the case of the house across the street on Chambers at the northeast corner of Chambers and First where two cases of typhoid had occurred, but where city water was used, that these two cases were children and that these children had played continually over at the corner house where the polluted well was located. At least one other case in the south side of town has also since been traced to this polluted well. Although the class found no actual typhoid germs from the well at the northwest corner of E. First and South Chambers, yet the well was badly polluted with intestinal bacteria proving the direct seepage of sewage into the well. It is probable that the first case of the child came either through a typhoid carrier or *possibly* from milk although the milk supply usually used by the family after being tested showed no signs of infection. The other ten cases may undoubtedly be traced to the polluted well

at the northwest corner of E. First and So. Chambers streets. Inasmuch as other wells in the neighborhood show pollution, it is quite probable that the city sewage system is at fault here as well as the private sewer, inasmuch as the grade of the sewer of the city sewers appeared to be too slight to carry off the flow properly, especially after a heavy rainfall.

It is not usual to find typhoid bacteria in well water, especially when the test is made some time after the epidemic. The fact remains that pollution had taken place and was still taking place and, as has been proven, that bacteria came from the human digestive tract and therefore came from sewers or privies. This is typical example of a surface water borne epidemic and is only one of hundreds that might be cited from different parts of the United States.

The serious part of the problem for the small city is shown through the inadequate functioning of the *local* health department. I was several days in the field, while I questioned a number of people living in the locality, not once did I get the impression that they had been told or knew that the water in the polluted well was unsafe to drink. The State Board of Health, as I later found, had made bacterial analyses which agreed with the class findings and these analyses must have been the property of the local health officer. But for some reason the findings did not appear to be known to the people of the neighborhood. This is certainly evidence which points to the fact that part time health officials must be replaced by local boards of health with a full time health officer who is educated along the lines of modern sanitation and hygiene. Public health is purchasable, but we have to pay a price for it.

That surveys may easily be made a part of the school work is easily proven by any teacher with a little exercise of ingenuity and tact. Help in making out score cards and in planning surveys can be obtained from the admirable volume of Horwood, entitled "Public Health Surveys" Wiley & Sons. Suggestions as to possible scope may be obtained by looking up some of the excellent city surveys published by the Illinois State Board of Health—the Rockford and Freeport surveys are examples. A very fine piece of work was done by Professor Winslow's students in a health survey of New Haven, Conn., published by the Yale University Press. An equally helpful survey is the Springfield Survey published by the Rockfeller Foundation and obtainable for a small sum. As an illustra-

tion of what can be done by college students giving a part of their time, I suggest the perusal of an article entitled "A Preliminary Report on a Sanitary Survey of Galesburg, Illinois," by Ella Devenney and George W. Hunter, III, published in the 1923 Illinois State Academy of Science Bulletin.

Work of this sort is stimulating and gives rise to a series of practical projects. Best of all it applies work in public health and hygiene to the very community in which such courses are given. It means increased dividends in interest both within the school and without. It helps make the courses in biology what it should be in the high school—an investment in public and for public-service service.

OCEAN CONFERENCE PLANS SURVEY OF UNKNOWN SEAS.

Plans for the most complete survey of the ocean from top to bottom ever attempted, have been inaugurated by a conference at Washington, representing scientific branches of the government and allied institutions under the auspices of the Hydrographic Office of the U. S. Navy.

Definite routes and areas have not yet been chosen, but the preliminary discussion indicates that instead of a globe-girdling expedition, a comparatively small section of the seas will be selected for intensive study. The Aleutian Islands region of Bering Sea and the Caribbean Sea are under consideration as offering unusual opportunities for scientific investigation, with the latter most favored.

One or more ships will probably be fitted out with a complete laboratory and equipped with the latest scientific apparatus for the first cruise. The sea bottom will not only be mapped, but the composition of the water, its density, temperature and currents which affect the distribution of marine plant and animal life will be studied at all depths.

Beside the investigation of the water and the life in it, specialists in various sciences will probably be landed on oceanic islands within the area covered by the ship.

In emphasizing the importance of this investigation, it was pointed out that five-sevenths of the surface of our globe is covered by the waters of the seas. The water area can produce far more food than all the land can ever be made to yield, and one of the purposes of the expedition will probably be to take an inventory of such food possibilities which will be needed if our population continues to increase. Fish, mollusks, and marine animals are dependent upon the microscopic plants that grow in the sea as far down as the sunlight penetrates. The floating mass of minute forms of vegetable and animal life, collectively called "plankton," varies greatly with slight changes in the temperature and composition of the sea water, according to laws not yet discovered but which the proposed expedition may aid in understanding.

The exploring ship will map the ocean bottom by means of the new sonic finder which determines depths by measuring the lapsed time between sending down a sound and getting back the echo from the bottom. By this instrument, soundings can be made by a ship in motion and much more easily and quickly than by the old way of heaving the lead.

The geologists of the conference expressed the hope that a study of the sediment being deposited on the ocean bed would lead to greater knowledge as to the age of the earth, the origin of oil and shale deposits, and the balance of oceanic and continental areas which is responsible for earthquakes.—[*Science Service.*

GENERAL SCIENCE A FOUNDATION STONE.[1]

By Henry P. Harley,

Fairmont Junior High School, Cleveland, Ohio.

"Laying foundations for vocations," the slogan for our convention, perhaps is a new objective to many of our general science teachers. We have been keeping before us such aims that seek to develop within the pupil certain habits resulting in clear thinking. In view of this the pupil is trained to weigh all evidence, to persevere in securing facts, to record results with accuracy, and to suspend judgment until sufficient evidence is present to warrant a conclusion. Further we are presenting to our classes such opportunities that open the great fields of science touching his everyday life; material that appeals to his needs and interests; material that opens to him the beauties of nature's laws; material that shall stimulate him to persevere in adjusting himself to our ever increasing scientific age.

The general science teacher, or better, the instructor of everyday science, should be inspired with the importance of his opportunities. Too often do we hear from him remarks of uncertainty as to enthusiasm and procedure. There is no subject in the curriculum fraught with a wider range of material, more contacts of interest or greater possibilities for application. The range of material and interest need not worry the careful teacher for his subject affords the only real unity, the unity of life.

The findings of natural science are of almost universal interest today. Active minds everywhere are seeking new fields for research. No subject or study can be rightfully pursued without the methods of observation and experiment. Moreover present day thought on political, social and religious topics is more and more using scientific data as their fundamental premises. Therefore in the words of Professor DeGarmo, "Wherever men work, in trade, in production, in government or courts, in charity or social reform, in education, in the home or the church, they need the methods of science in applying effectively the truths that science has revealed."

The general science teacher even though possessed with all these aims, methods, materials and enthusiasm works with a disadvantage if he does not project into the after life of his pupils a vision of requirements, opportunities and interests connected with their daily work of the future. As he faces boys and girls of twelve and fourteen years he should realize he is

[1]Read at the Indianapolis meeting of the C. A. S. & M. T., Nov., 1923.

laying the foundation for future citizens to understand their world at the ages of thirty and forty. A great factor in their future lives for happiness and richness of experience will be their vocation. While the general science teacher is too busy to teach vocations as such he cannot afford to miss the chance of laying foundation stones in the characters of potential citizens that will assist in making of their future work not a task of drudgery or necessity, but a trade or profession that will be a pleasure because they understand the interesting phenomena surrounding their everyday lives.

Accordingly the elementary science teacher being fully aware of the fact that for many of his pupils his course constitutes the greater part of their science instruction, should keep in mind the field of vocations where his pupils will work in after years. It is scarcely necessary to recall the impossibility of foretelling in all cases the future vocation of the adolescent pupil. But we know he will likely be found somewhere in agriculture, in business, a trade or profession.

We may for our own purposes classify the vocations of the world somewhat as follows:

I. Professions
- Ministry
- Teaching and School Administration
- Journalism
- Law
- Statesmanship
- Medicine
- Dentistry
- Nursing

II. Fine Arts
- Painting
- Seulpture
- Music
- Poetry

III. Applied Art
- Domestic Economy
- Bookbinding
- Printing

IV. Engineering
- Civil
- Municipal and Sanitary
- Mechanical
- Electrical
- Mining
- Metallurgical
- Chemical
- Architectural

V. Commerce
- Business Administration
- Accounting
- Secretaryship
- Salesmanship
- Advertising

VI. Agriculture
- General Agiculture
- Horticulture
- Landscape Gardening

VII. Building Trades
- Carpentry
- Bricklaying
- Plastering
- Plumbing
- Cabinet-Making
- Painting and Decorating

VIII. Machine Trades
- Machinist
- Experimental Worker
- Pattern Maker
- Blacksmith

IX. Transportation
- Operating Signal Devices
- Traffic Administration

As the teacher faces his class he knows that each pupil before him will some day be working in connection with one of the vocations listed above. Let us see how their training in the general

science course may have a bearing on the success of our future citizens in regard to their daily work.

The direct bearing of science instruction to medicine, engineering, domestic economy and agriculture is self-evident. However, while science instruction should not become "an austere and solemn business," the introductory class is not too early to train for caution and rigor in testing generalizations essential in these great applied sciences of today. Moreover I would like to emphasize the importance of science instruction in rural districts. The farm and its equipment furnishes a great laboratory for study and research. It is a most fascinating place for a scientific student. The principles underlying the common phenomena such as the difference between dead grass and real hay have real interest. Instilling a love for scientific study ought to keep more of our young people on the farms with a desire to possess their own property.

Many of the academic pupils will go out into such learned professions as the ministry, teaching, law, statesmanship, etc. Instead of there being antagonism beteween science and religion, there should be hearty accord. What more inspirational and reverential study can there be made anywhere, except in the Bible itself, than the infinite forces of nature or the marvelous harmony of the spheres. Every lesson should make a lasting impression as to the wonders and beauty surrounding the adolescent pupil. So instead of hearing from the pulpit such information as "A comet is a ball of fire flung from the hand of an angry God to warn the grovelling dwellers of earth," we shall hear emphasized rather from the scientifically trained minister: "The heavens declare the glory of God and the firmament showeth his handiwork."

Teachers of all grades and subjects are in many places being called upon to pursue their work in a scientific way. Recently there came from headquarters of the Cleveland Board of Education this request to the teaching staff: "What new things did you try to do this year?" This request was not made for the purpose of discovering what new things we read about, but what we as teachers discovered in a scientific way by experimentation. Educational research and methods of teaching will be done increasingly according to the methods of science and will be based on the data of science.

What lawyer representing criminal or civil cases would hope to succeed in the affairs of our daily life without early acquiring

the habits of scientific procedure, or early beginning that acquisition of information that he may wish to call upon with scarcely a moment's warning. A court trial may at very short notice develop into a contest of scientific discussion.

The teacher with a vision sees a number of his pupils following these responsible positions with an early training in the general science class, laying the foundation for broadening their view of life, bringing into contact with real materials those who will rather largely deal with abstract ideas. Quoting the F. W. Parker School Year Book of 1915, "Their concrete experience must be rich and varied if their mental advancement is to be full and free."

A great many children of our public schools will go out into commercial life, into the subordinate positions of accounting, secretaryship, salesmanship, and advertising. Knowing that modern commercial enterprises, especially manufacturing, with well equipped laboratories, have scientific data as the foundation of their very existence, the general science teacher will see these pupils greatly handicapped unless they have developed within themselves the appreciation of, and ability to do, reading and research work in the sciences underlying the particular business of the firm for which they are working. Moreover, the teacher in correcting experiments recorded in note books reminds himself continually that these future bookkeepers, stenographers and salesmen will be face to face with the proposition that errors represent money in the business office, untidiness and poor form will mean demotion or discharge; while on the other hand, accuracy, initiative, the artistic touch, and neatness result in promotion and further opportunity.

The building and machine trades afford a vast field for scientific study and application. Composition, formation or growth of raw materials, tools and tool steel, machinery, care of machines, transmission of power, veneering, soldering, effects of heat on materials, stress and strain on materials, electricity and care of the finished product, all have for their foundation scientific principles which the tradesman should be able to appreciate. The thoughtful general science teacher will remember the great many boys and girls who go out into industry. If he succeeds in stimulating their interest in science sufficiently, creating a desire to study the science of their own trade in after life, his efforts are most valuable.

But let us be real scientists and not go to extremes. Let us

not presume to outline definitely the future course of the pupil. True it is elementary science will pave the way for future special sciences, and the teacher can accomplish much in the way of guidance in the activities of the future citizen, but may we never forget to provide a field for the growth and cultivation in the pupil of that initiative which will explore many interests and find those contacts appealing to him most strongly, and for which he is best adapted. In the words of Mr. Robert M. Gay: "Let us have at least one part of our brains from which the pedagogue shall be excluded; let us reserve at least one large section free from scientific farming, one tract of wild woodland with plenty of underbrush, where commercial fertilizer shall be unknown, and humus, or leaf mould, blow in from the four corners of the earth and the interstellar spaces, shall form a rich deposit in which the native sprouts can germinate, take root, and flourish."

Let us therefore as teachers of general science have a vision of the great world of vocations into which our pupils will sooner or later go. We should not seek to determine their destiny, but guard against habits that will militate against efforts toward success and good citizenship. For the future vocation of the pupil, general science, with its wealth of material, its many-sided interests, with life as its unity, and clear thinking as its goal, is a foundation stone.

PREPARING SOLUTIONS.

The preparation of photographic solutions is generally a simple matter, yet, failures occur often and not always with beginners, says a writer in *Photographische Mitteilunger*. It should be made a rule to triturate all large crystals before dissolving them. This saves time, and one may be spared the need of warming the water. Many salts dissolve very slowly in large crystals, so that eventually one may have to resort to the heater to help out.

If a solution that consists of several ingredients is to be made, it is always advisable to dissolve one of them before adding another. For some mixtures, it is necessary to add the different articles in a given order so as to avoid precipitation. More or less warming of the water to accelerate solution is recommended in all cases where the substance may be affected by the light. This should be remembered, particularly when mixing developers.

When preparing concentrated stock-solutions, the quantity of water should not be scanty, since a solution that keeps well in summer may be partly precipitated in cold weather. If precipitation occurs, the best thing to do is to set the bottle in warm water, leaving the cork loose until the precipitate is gradually redissolved. This will be successful usually if decomposition has not taken place. *[Photo Era.*

TRADE OF THE UNITED STATES WITH LATIN AMERICA: SOME RECENT CHANGES.

By Bessie L. Ashton,
University of Illinois, Urbana, Ill.

Recent enthusiasm over the increase in the trade of the United States with Latin America might give the impression that only since the Great War has this trade been important, but such is not the case. As early as 1900 the value of this trade was $325,000,000, the imports from Latin America being worth about $60,000,000 more than the exports to that region. In 1905 the total trade represented a value of $183,568,000 greater than in 1900.[1] The gain during the two next five-year periods was $173,656,000 and $173,804,000, respectively, the increased demand for Latin-American products being offset by the general depression in these countries and the limitations in facilities of transportation. By 1914 both exports and imports had increased to a value more than 150 per cent greater than in 1900. Perhaps the gain is made more evident by noting that the trade had risen from 23 per cent of the toal imports and nine per cent of the total exports of the United States in 1900 to 26 per cent of the imports and twelve per cent of the exports in 1914. A slight falling off took place in the exports to Latin America in the latter year due to the lowered purchasing power resulting from business and financial depression in these countries which just preceded the war.

The Great War, with its attendant disturbance in commerce and shipping, and the shifting to the United States of much of the trade formerly going to Europe, resulted in a great increase of our total trade, that to Latin America representing a sum close to one billion dollars in 1918, exports having increased 157 per cent and imports 110 per cent over the values for 1914. The relative decrease during the war years in the per cent of our exports going to Latin America merely indicates the enormous demand made on the United States by Europe, causing an increase of European trade which outdistanced that with other parts of the world.

The increase shown by the figures for the years 1914 to 1918 continued until the peak was reached in 1920 with a statistical value of $1,807,475,000 for imports and of $1,564,128,000 for exports for the calendar year, or a gain over the latest statistical pre-war year (1913-1914) of 276 per cent and 363 per cent, respectively. Correction for the rise in price of commodities

[1] Figures given by various authorities differ somewhat owing to lack of uniformity in gathering and compiling statistics.

up to this time, which accounts for part of the increased value, give gains of 120 per cent for exports and 58 per cent for imports over the 1913-1914 figures, instead of the larger increase stated above, if the price index of the Federal Reserve Board for raw materials and consumers goods, which figure most prominently in our Latin American trade, is used.

In 1921 a noticeable decline took place due to a number of factors among which were the highly inflated prices of 1920, giving a greater apparent than actual increase; overstocked markets, resulting from feverish buying in 1919 and 1920; steady deflation of prices, which caused merchants to buy cautiously in expectation of still lower prices; and the appreciation of the American dollar. Next to the general depression in all these countries, the greatest obstacle to trade was the high quotation of the American dollar, which threw trade to European countries where currency was depreciated, though there was some competition with other countries bidding for Latin-American trade. The greater shrinkage in value of imports, due to a greater decline in prices of raw materials, shifted the balance of trade in favor of the United States, instead of against it, as was formerly the case.

Figures for the fiscal year 1922 show a further decline in value of trade with Latin America because of the drop of $235,572,000 in the value of our sales to that region. This was due to several causes. Continued business depression throughout South America lasting until late in the year; the financial collapse in Cuba and the return of American goods for which they were unable to pay, marking a decreased market for our exports; the reduction of shipments of packing-house products from Uruguay due to the economic crisis in that country; injured credit in Peru due to canceled orders and dishonored drafts during the previous year or two; and the revival of participation of European countries in trade with this part of the world as shown by re-exports of Chilean nitrate from Belgium to the United States and by increases of exports from Cuba to France, Great Britain, and Germany, though exports to the United States register a decrease, are some phases of the trade situation. The resumption of the usual balance of trade in 1922, that is, an excess of imports over exports, indicates the return to more nearly normal conditions in the trade relations between the United States and this region. The slight gain in total trade during the year is also reassuring.

Lines of Trade.

An inquiry as to the lines of trade responsible for the increase noted during these years reveals the fact that it is an increase of old, well-established lines of trade rather than the development of new ones that explains the greater part. This is especially true of imports and of probably 75 per cent of the *increase* in exports. New trade, therefore, created or relocated on account of the war, represents only about $132,000,000 on the basis of pre-war prices, or $238,000,000 on the basis of prices at its close.

Imports.

The imports into the United States from Latin America are mostly food-stuffs and raw products used in the industries, and, in many cases, Latin America is the principal, if not the only market outside itself where the United States can secure these commodities. Of these coffee, sugar, hides and skins, petroleum, cacao, bananas, and nitrate of soda are the most important.

Among the leading imports of the United States is coffee, which, though showing many fluctuations from year to year, has steadily increased from the earliest period. In 1900 we consumed more than 787,000,000 pounds, in 1910, 873,000,000 pounds, and in 1920 the amount had risen to 1,417,000,000 pounds of which Latin America supplied nearly nine-tenths. This trade is especially important with Brazil and an increase or decrease in trade with that country usually may be traced to favorable or unfavorable conditions of the coffee industry. That increasing or decreasing values do not register correctly the changes in volume of trade is clearly shown by the following table, which indicates an increase of over 50,000,000 pounds

Imports of Coffee From Latin America

	Thousand Pounds	Thousand Dollars
1911	748,810	90,536
1912	885,990	121,535
1913	836,440	102,107
1914	984,894	100,566
1915	1,216,218	111,638
1916	1,158,205	117,450
1917	1,277,736	121,365
1918	1,041,123	98,112
1919	1,250,793	246,011
1920	1,255,184	244,364
1921	1,308,382	138,543

in the import of coffee from Latin America in 1921 over 1920 though the value received was nearly $106,000,000 less than in the previous year.

The import of hides and skins represent a greater distribution of supply—Argentina, Mexico, Brazil, Cuba, Uruguay, and the north-coast countries contributing considerable amounts. The trend was, in general, upward until 1920 and 1921, value and weight both showing a marked decline in the latter year. In 1921 the weight of cattle hides imported from Argentina fell some twelve million pounds below the amount in 1913-1914, and the value represented only about five-eighths of that of the earlier year due to a price of five cents less per pound. Cattle hides account for the greater part of the import, though sheep skins from Argentina and goat skins from Brazil are noticeable items.

The import of mineral oil, mostly from Mexico, registers the increased demand for locomotive power during and since the war and the unparalleled development of the oil wells of Mexico. The amount entering the United States from that country increased from 737,712,000 gallons in the fiscal year 1913-14 to 5,391,842,000 gallons in the calendar year 1921.

As Cuba contributes ninety per cent or more of the cane sugar imports from Latin America, and as that commodity represents about four-fifths of our imports from that country, the trade in sugar is a record of the conditions of that industry in Cuba. The increasing appetite for sugar in the United States and the influence of close political and financial relations between the two countries, together with that of the preferential tariff of twenty per cent on Cuban sugar, is recorded in the increase from an average of 3,940,685,000 pounds imported in the three year period 1911-1913 to 6,246,805,000 pounds for the average for the years 1919-1921.

Cacao, mostly from Ecuador, increased from an average import of 100,600,000 pounds for the period 1911-1913 to more than twice as much for the average of the years 1919-1921. Shipments of wool increased notably, the average for the years 1919-1921 being from five to six times as much as for 1911-1913. During this time the imports of wool from Argentina increased from about one million dollars in 1914 to approximately twelve million dollars in 1921, in spite of prices which averaged from four to seven cents below those of former years, indicating a taking over by the United States of part of the trade previously going to Europe. The decline in imports in rubber is partly due to wasteful methods of gathering the rubber in Brazil and partly to the growing production of rubber on the plantations

in the Federated Malay States. Bananas, chiefly from Costa Rica and Honduras, show a decrease for the three year average of 1919-1921 over that for 1911-1913 of about three and one-fourth million bunches, bananas having been replaced as a crop of first importance in those countries by coffee. Copper, next to nitrate as an import from Chile, shows the moderate increase of sixteen per cent in weight and twenty-three per cent in value as an average for the three year period of 1919-1921 over that of 1911-1913.

In 1913 the United States took 31.08 per cent of the total Latin American exports in spite of the fact that many of the commodities were of a kind for which the United States felt no especial need, for example, wheat, meat, corn, etc. If such products are eliminated, and also the interchange between the countries themselves, exports to the United States would equal nearly two-thirds. At the close of the war nearly all of this competitive trade went to the United States.

EXPORTS.

Exports from the United States to Latin America covered a very wide range prior to the war and, with war conditions and other manufacturing countries cut off from trade with them, they called upon the United States to supply them with manufactures of all kinds, including those usually obtained in Europe. Before the war (1913) the United States furnished 24.79 per cent of the imports into Latin America, the United Kingdom 23.73 per cent, Germany 16.55 per cent, and France 8.34 per cent. With all but six South American countries—Brazil, Bolivia, Paraguay, Uruguay, Chile and Argentina, the United States was by far the chief source of their imports. At the end of 1916 the United States was furnishing 51.17 per cent of Latin American imports, and at the close of hostilities in 1918 the percentage had reached seventy per cent of all imports and about ninety per cent of all imports other than exchanges with each other.

Chief among exports are manufactures of iron and steel, including pipes and fittings, wire, steel rails, structural steel, sheets and plates, nails, tin plates, metal working machinery, locomotives, typewriters, sewing-machines, and pig iron, and cotton textiles. Other important items are agricultural implements, automobiles, and tires for automobiles, leather boots and shoes, bituminous coal, mineral oils, lumber and lard.

The most significant change that has taken place recently

is the gain in exports of cotton cloths, which rose from 168,615,000 yards worth $11,521,000 in 1911 to 547,477,000 yards worth $147,128,000 in 1920, the chief purchasers being Cuba, Colombia, Argentine, Venezuela and Mexico, though practically all parts of Latin America buy cotton textiles of the United States. The rapid rise during the war years when the textile manufacturing nations of Europe which were accustomed to furnish a large part of the supply were unable to do so is noticeable.

Lack of facilities for manufacturing in Latin American countries give manufactures of iron and steel an important place in their import trade, and United States iron and steel products enter practically every part of this region. Though held back during the war due to the more urgent demand for such articles by the warring countries and the attention to the preparations for war at home, exports of iron and steel products from the United States to Latin America rose to $105,231,000 as an average for 1919-1921, being nearly four times the average for 1911-1913.

The rapid increase in the number of commercial and passenger automobiles exported is striking, being nearly twenty times the number in 1920 as in 1911. The falling off in the number sent to other parts of Latin America, especially to Argentina and Cuba, during the general slump of 1921 was partly met by an increase to Mexico of nearly 3,000. An adjunct to the automobile trade is the one in automobile tires, which shows a phenomenal increase for the six years, 1915-1920, from $509,000 to nearly $12,000,000, but this joined other trade in the decline of 1921, reaching a value even less than that of 1917.

The increase of exports of bituminous coal of from one to two million tons annually during the war years indicates the inability of Great Britain to continue the customary shipments of coal abroad. Motion picture films represent a new line, having an export value in 1913 of only $21,000, but the upward trend to a value of $1,305,000 in 1921, the year of decline in values of most lines of trade, accords well with the motion picture craze in our own country. Lard is an export showing a marked increase, especially in our trade with Mexico and Cuba. Other exports that show the same trend are newsprint and other paper, binder twine, cement, flour, condensed milk, and

butter and cheese, all of which enter more or less into Latin American trade.

Summary and Conclusion.

From a careful study of the statistics of the trade between Latin America and the United States the following conclusions may be drawn:

1. Before the breaking out of the Great War trade between these parts of the world was already undergoing a considerable increase.
2. A very substantial but not phenominal increase of trade took place between the years 1913 and 1920.
3. The increase has been mainly along lines already followed, rather than new lines created or taken over because of the war.
4. There is an increase in volume, but not necessarily one commensurate to the increase in value.
5. Increase or decrease of trade may be caused by financial, political, industrial, or social conditions both within and without the importing and exporting countries.
6. The imports are chiefly raw products used in the industries and alimentary substances.
7. The import trade is large considering the degree of similarity of products.
8. Exports include certain lines of raw materials and a great variety of manufactured products.
9. Exports of iron and steel products, of cotton cloths, and of specialized lines are increasingly important.
10. The proportion of the trade of the Northern Republics belonging to the United States is much greater than that of the Southern Republics, therefore the greatest chance for development of trade is in the latter.
11. The United States has been able to secure a portion of the trade formerly belonging to European countries.
12. Great Britain is regaining a portion of the trade lost during the war years. Germany's trade shows rapid recovery during 1922.
13. To retain that portion of the trade now held, the United States must give careful attention to all of the conditions influencing trade.

Bibliography.

1. Monthly Summary of Foreign Commerce of the United States, December 1913, 1916, and 1919.
2. Trade and Economic Review, United States Trade with Latin America, Bureau of Foreign and Domestic Commerce, for 1921 and for 1922.
3. Bulletin of the Pan American Union, especially Dec. 1918, Dec. 1922, and Volume 54, 1922.
4. Supplement to Commerce Reports on Cuba, Mexico, Brazil, etc.
5. Commerce Reports, A Weekly Survey of Foreign Trade.
6. Trade of the United States with the World, Misc. Series, No. 63, Bureau of Foreign and Domestic Commerce, 1916-17.
7. Annual Review of the Foreign Commerce of the United States, 1919.
8. Pratt, Edward E.: Trade Conditions in Latin America as Affected by the European War, the Annals of the Amer. Academy of Pol. and Soc. Sci. 60:72-97.
9. Pepper, Charles M.: American Foreign Trade.

To Our Mathematics Friends,

Owing to circumstances beyond our control it has been impossible for the Editor to present any articles of a mathematical nature, outside of the Problem Department, to you this month. Not because of lack of material, for we have plenty of high grade manuscript. The December issue will, however, contain many articles which will delight the mind of the mathematics teacher.

EDITOR

THE SELECTION AND ORGANIZATION OF THE MATERIAL AND ACTIVITIES FOR A DEFINITE UNIT OF WORK IN GENERAL BIOLOGY.

By John M. Presson, Girard College

Philadelphia, Pa.

Introduction.

Good teaching is the result of thought and care on the part of the teacher in getting material and organizing it for class work. No teacher, regardless of scholastic preparation, can ever hope to reach that stage in teaching where preparation for each day's work is not essential. Each lesson should be carefully planned in order to prevent lagging in the procedure and a manifest sameness to exist in the work day after day. Teachers must be interested in and enthusiastic over their work, if the same qualities are to be expected of the pupils. Pupils accomplish very little in school work if they are not interested. It is assumed that the teacher has sufficient knowledge of the courses being taught to handle them successfully, but without constant effort on the part of the teacher very few changes are introduced in the work and often important details are omitted altogether through carelessness or the so called "over-sight."

Careful planning alleviates these faults and keeps the teacher "keyed up," interested, demands changes, causes introduction of new material, brings about different methods of attack for different classes, and makes the work more stimulating for the pupils. Good planning, also, on the material side, keeps the teacher posted on the best text-books to be used; the most valuable references to be found in text-books, encyclopedias, and periodicals; the illustrative material to be used; and the planning of large units of work for the course.

The topic "Pollination," of which a plan for the work follows, is organized for a class in the second year of the High School.

LESSON PLAN

TYPE:	Inductive.
SUBJECT:	Pollination.
CLASS:	Second year high school.
SIZE OF CLASS:	20 to 30 pupils.
DATE OF PRESENTATION:	About the first week of December or the first week of May.
MATERIAL:	Flowering potted plants of various species illustrating, simple, specialized, and composite flowers with special emphasis upon the simple varieties; charts; diagrams; five compound microscopes; five glass slides with cover glasses; and colored crayon for blackboard sketches.
TEACHERS AIM:	To teach what pollination is, how it is brought about, and its importance to man.
PUPILS AIM:	To find out what pollination is and why it is important.
TOPICS:	I. Function of pollination. II. Self pollination. III. Cross pollination.
TEXT-BOOK:	Any well organized standard high school textbook of Botany or General Biology.
TEXT-BOOK REFERENCES:	Andrews—Practical Course in Botany. Berger and Caldwell—Introduction to Botany. Transeau—Science of Plant Life. Gruenberg—Elementary Biology. Moon—Biology for Beginners.

When the work on the flower is started, the second lesson, a trip is taken to the green house to see flowers grow, bloom, and mature in their natural habitat, as far as possible, in the winter. A trip is taken around the campus or to one of the city parks when the work comes during the spring term.

METHOD OF PROCEDURE.

A. A brief review of the preceding lessons on the flower:
1. What is a flower?
2. Why do plants produce flowers?
3. How do you account for the different colors, sizes, and shapes of flowers?
4. Do all flowers have a sweet perfume?
5. What are the two groups of organs that make up a flower?
6. Name the parts that constitute each.

During this procedure charts and blooming flowers would be used. Various pupils in the class would be called upon to point out on the charts the organs of a flower. Different flowers would be torn to pieces to illustrate this phase of the work. Sketches of the essential organs, the stamens and pistils, would be made on the blackboard with colored crayon. Before the class, pollen grains would be dusted on glass slides by the teacher from stamens of a flower selected, a drop of water would be put on the pollen grains over which a thin cover slide would be firmly placed. A slide would be placed under each of five

compound microscopes. After the entire class, taking about five minutes, had seen the microscopic preparations, the teacher would ask:

1. What did you see?
2. What are the grains called?
3. Did you see very many?
4. Do the pollen grains move?
5. How do you suppose the pollen grains get into the air and on the other organs of the flower?
6. Now that you have mentioned four ways that the very small pollen grains are carried about, which organ of the flower do you think is best fitted to catch and hold the pollen?
7. Why do you think the pistil is supposed to receive the pollen?
8. What is this process called?

Class, we have learned the names of the parts of the flower and the particular work that each has to perform. We have seen that pollination is the transfer of pollen from the anther of the stamen to the stigma of a pistil in a flower. We shall now try to find out why pollination is carried on in the flower, how it is done, and the types of pollination..

B. Topic I. The Function of Pollination.

All the plants that we see daily, enjoy, and use for our own benefit grow from seeds. Seeds are produced by plants as a result of the growth of flowers. All seed must have a covering, a storehouse for food, and a very small organ, which we call the embroyo, in which the germ of life is present. It is through and by means of its seeds that a plant is able to reproduce itself.

1. How do the pollen grains reach the pistil?
2. What takes place when the pollen grains reach the stigma of the pistil?
3. What are the small undeveloped organs in the ovary called?
4. What do we call the little organ that "goes down" to the ovules?
5. Does the pollen tube carry anything down to the ovules?
6. What are they called?
7. When the generative cells reach the ovules a certain work has been done, what it is called?

We have found out that the function of pollination is fertilization in order that the plant can reproduce its kind. Our next step is to see if all pollination is of the same kind.

Topic II. Self Pollination.

We know that pollination is the transfer or passage of pollen from the anthers to the pistils in flowers. In some flowers the pollen never reaches the pistils of any other flower than those that bore it.

1. What kind of pollination is this called?
2. Are many flowers pollinated in this way?

3. Why are such few flowers self pollinated?
4. What agencies do you suppose help in bringing about self pollination?
5. You have mentioned five means: wind, rain (water), certain insects, birds, and the natural position and growth of the essential organs, which one means do you consider the surest for self pollination?
6. Name some plants that are self pollinated.
7. What does the term, "Nature abhors self pollination," mean to you?

We have seen that self pollination takes place in nature, but to a very limited extent. The self pollinated plants are of very little importance to man. Yet, these plants can produce seeds for reproduction only through self pollination, proving this process is vital to the particular plant.

Topic III. Cross Pollination.

Self pollination is the passage of pollen from the anther to the pistil in the same flower. We have discussed this process and have found out how it is brought about.

1. When pollen passes from the stamen of one flower to the pistil of another flower, what is it called?
2. What agencies help to bring it about?
3. Which is the more important in cross pollination, birds or insects?
4. Name four insects useful in cross pollination.
5. Tell in your own words how you think the flowers of a field of buckwheat are cross pollinated.
6. Name some cross pollinated flowers.
7. Why are cross pollinated plants usually strong and health?
8. From what we have leaned, tell why cross pollinated plants are of an advantage to man.
9. What is the importance of cross pollination to man?
10. Mention three plants that have been developed by Luther Burbank through cross pollination.

Summary.

1. Define pollination.
2. What is the function of cross pollination?
3. Name two types of pollination.
4. Give the advantages of each.
5. What are the disadvantages of each.
6. Tell how cross pollination is brought about.
7. What is the economic importance of cross pollination to man?

This lesson plan, though the nature of its proceedure is inductive, the object of which is a direct tendency towards the appreciation of the plants and animals around and about us at all times. There are but few pupils, after taking work of this nature, that do not build up attitudes and habits of the right kind which grow stronger and better as they go through life. The teacher can only offer the stimulus as a guiding force; the pupils must furnish the initiative and interest.

Bibliography.

Charters, W. W., Methods of Teaching, Chapter XIX.
McMurry, C. A. & F. M., The Method of the Recitation, Chapter XIV.
Strayer, G. D., A Brief Course in the Teaching Process, Chapter XVI.
McMurry, How to Teach, Chapter III.
McMurry, Method of the Recitation, pp 329-39

A PLEA FOR THE STUDY OF INSECTS IN SECONDARY SCHOOLS.

By W. V. Balduf,

University of Illinois, Urbana.

Occasionally there comes to the university a student who has had a special course in the study of insects in his high school years. He comes with eagerness to satisfy an enthusiastic desire for more knowledge concerning these animals. Students who have been privileged thus to indulge their interest in insects in their pre-college work are relatively few. They generally come from the larger high schools where diverse and more specialized subjects are taught and the larger number of teachers permits the employment of one who has the necessary training for teaching a course in entomology.

Whether or not the more special study of insects is made available to high school and grade students, there is no gainsaying the fact that boys and girls have a natural interest in the forms of life in their surroundings. The beauties of floral colors, the charm of bird music, the variety and abundance of interesting insect life are among the first loves of children who have a normal contact with nature. Inasmuch as plants and animals exhibit phenomena, such as locomotion, acquisition of food, and methods of defense and protection, which children recognize as modes of conduct also characteristic of themselves, the study of these forms is a logical and essential one in directing the student to a proper understanding of himself and his environment. His physical welfare will hinge much on his knowledge of the natural forces that act upon him or from his environment. His mental interests are normally rich if he is permitted to pursue his inclination to associate with appealing natural phenomena that engage his love of beauty and challenge his skill to investigate and explain the mysteries that hedge us in on all sides. There need be no fear that such studies will lead to shallow or unworthy habits. We are a part of the same nature whose study is advocated, and man is governed by the forces he sees applied in the objects of his study.

One is confronted frequently by the fact that the boy or girl of high school and college ranks lacks this normal spontaneous enthusiasm for nature. Interest is furthered by a capacity on the teacher's part to supply definite information and to suggest to the student other avenues of departure for his study and investigation. The responsibility for the decadence of interest

must perhaps be laid to the facts that it dies from a lack of sympathetic and intelligent nurture or is smothered by an illogical mode of presentation, or a wrong choice of subject matter. The fundamental proposition to be emphasized is that the early interest of children in flowers and birds and insects will persist and grow indefinitely if it is allowed room for expansion and given a proper diet of information and direction. The basic justification for emphasis upon the study of nature lies in the fact of its cultural value, its general biological significance to man himself and its ever increasing importance in the struggle of man to make a living commensurate with his rising standards of life.

Nature study in general has enjoyed a much deserved impetus in the last decade, but what may probably be described as the most extensive and most fascinating field for teaching of elementary biology has scarcely been entered. This branch of natural science is entomology. Truly, the gay butterfly and the far-jumping grass hopper are usually included in whatever nature study is taught, but the abundance and variety of forms of insects is such that a much more prolonged and profound study of them is at once justified and desireable. Of the 500,000 and more known species in the animal kingdom, 400,000 or at least three-fourths are insects. Furthermore, these species of insects are represented by a comparatively large number of individuals. They live in numerous types of situations, exhibit an endless variety of habits and adaptations to their varied habitats, exemplify practically every biological principle, and among them are admittedly man's most dangerous rivals for supremacy in the world as well as some of his most effective aids in the suppression of their rivals. It is not believed that insects should supplant other common invertebrates and the usual vertebrate specimens for laboratory study, for they represent only one of the several rather distinct types of animals. But their abundance, their economic value, their availability and their convenient size for field, laboratory and class study bespeaks for them porportionally much more time in the course of study than they usually receive. A special high school course in insects following a more general study of the animal phyla would certainly meet with the whole-hearted response from students. Such a study of insects implies a fairly thorough familiarity on the part of the teacher with the structure, classification and bionomics of insects, especially of the major orders Orthoptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera and Diptera. A

knowledge of the character and source of certain books, as well as of equipment and technique for collecting, mounting and preserving insect specimens are other features essential to teaching entomology in high school.

It is not out of the question to acquire such a fund of facts by one's own efforts privately. However, teachers engaged regularly in public school instruction, who have acquired something of the biological point of view, can fortify themselves materially for entomology teaching by engaging in a summer session of study of insects at a university. Undergraduates who contemplate teaching general biology may become fairly trained for such an undertaking by taking two or three semesters of entomology and some work in the fundamentals of botany and zoology. This amount of training would provide such essentials as the means of recognizing orders, families and the more common genera and species, the naming of structures, the modes of development, habits of feeding and reproducing, modes of protection and defense, and many other phenomena and adaptations exemplified by insects in a striking manner as well as a general biological background for the appreciation of insect phenomena. A knowledge or organized effort for combating insect pests is always imperative in view of the ever increasing menace by insects to man, his health, and his products. Briefly, the gipsy moth, the European corn borer, the Mexican bean beetle, the Japanese beetle, the oriental fruit moth, not to mention many others, already established in our midst are among the more recent factors that already bring wide devastation in our land and threaten constantly to invade the central lowland garden of our country. Effective resistance to insect pests in the future will depend more and more on a wider and a more intelligent appreciation of their seriousness, their habits and the best means of control. The extension of this information cannot be accomplished more effectively anywhere than by making it a regular part of public instruction. On the other hand, a knowledge of the habits and means of recognition of beneficial insects is quite as important. Man can probably always do much less in controlling his insect enemies by artificial means than parasites and predators do for him without his aid. To distinguish between enemy and benefactor requires more than a superficial consideration of the insects.

Therefore, there seems to exist urgent need for an expansion of our teaching of insects. It is not entirely an economic urge.

It is quite as much an urge to keep alive the wholesome and spontaneous interest of young people in the fauna they have known before they were formally taught. One of the most serious and immediate needs is for teachers with a definite, adequate and well organized fund of knowledge about insects. A wider spread of such knowledge will stimulate the normal development of the mind of children and youth, satisfy their love of the beautiful, of adventure and of mystery, and preserve the normal inquisitiveness that leads to the making of research workers who contribute to the broadening of man's horizon and the enrichment of his life.

LABORATORY METHODS IN NATURAL SCIENCE TEACHING II.

HARRY A. CUNNINGHAM,

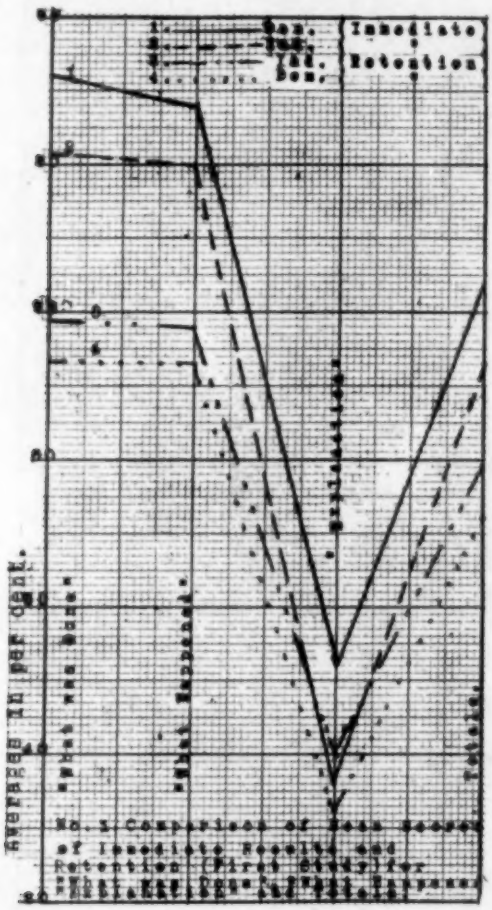
The University of Kansas, Lawrence.

In a recent paper I reviewed two studies, which I have made, bearing upon laboratory methods in natural secience teaching. The immediate results were summarized in that paper. After a period of time, each class was tested upon each experiment a second time. The re-testing was done in the same manner in each study. After a period of time, the members of each class were given the title of the experiment that had been done previously and told to write as much as they could remember of "what was done," "what happened," and of the "explanation." A period of approximately one month elapsed between the time of doing the experiments and the re-testing in the first study. In the second study, a period of approximately three months elapsed. By a detailed study of individual cases we observe the following points that do not appear in the general results as shown in graphs Nos. 1 and 2.

Neither method seems to be any better for slow students than for bright ones. This conclusion is based upon data obtained by getting the mean score made by each individual on all studies given him by lecture demonstration and the mean score made by each individual on all studies given him by individual laboratory work. These mean scores for each individual were compared graphically with the intelligence scores.

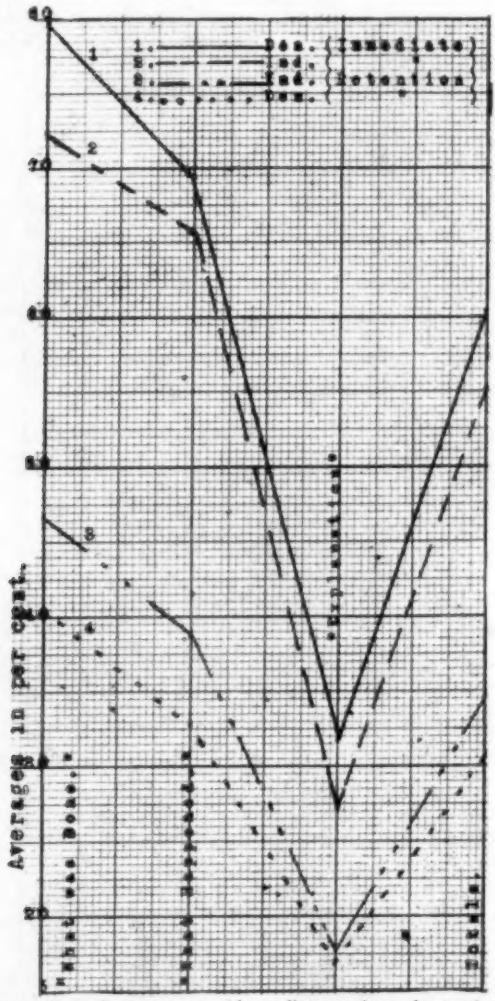
There is a very great variation in the mean scores made by individuals under the two methods and in the relationship between immediate results and results obtained after a period of time had elapsed. Very few individuals ranked compara-

tively high under both methods and in immediate results and retention. Some ranked comparatively higher, in both immediate results and retention, in exercises done by lecture demonstration. Others ranked comparatively higher, in both immediate results and retention, in exercises done by individual laboratory work. Some made a comparatively higher mean score on immediate results, under both demonstration and individual work, than they made on the re-test after a period of time had elapsed. Others made a better comparative showing upon the re-test in both demonstration and individual laboratory work, etc. In the first study, four individuals made their highest mean score on the re-test and upon exercises that had been done by individual laboratory work. These great individual differences are covered up entirely by a consideration of the general results alone.



It did not take the dull student any longer, on the average, to perform the experiments than it did the bright ones. Now turning to a consideration of the general results as shown in graphs Nos. 1 and 2, we observe the following points.

1. The mean scores, after a period of time, are just the reverse of the immediate results in each of the three divisions, "what was done," "what happened," "explanation," and also in the totals. In general, a higher percentage of the work done by individual laboratory work is retained. This is true for each study. In individual laboratory work, the directions were written and were received, therefore, through the eye instead of through the ear as was the case in lecture demonstration. This may be a factor in determining these results. A greater



No. 2. Comparison of mean scores of immediate results and retention (score study) for "what happened," "what was done," "explanation and totals.

number of the senses were brought into play in individual laboratory work than in lecture demonstration. In this way it would seem that a greater number of associations would be made and that this would aid in better assimilation of the subject matter and result in a more lasting retention.

2. Scores, under the "explanation" division are uniformly low. This seems to indicate that we are not teaching students to reason scientifically; the very thing that natural science teaching is supposed to accomplish as well or better than any other subject. Why are students not learning to solve problems scientifically? Is it not true that few teachers have made even a beginning in analyzing the mental processes that are necessary in the mastery of laboratory exercises? There are many different types of thought problems. Few teachers are even conscious of the various types. There is a best method of solution for each of the various types. You may have two students who are equal in ability and equally well informed in subject matter. You may give one student training in the best method to use in solving the various types of thought problems and give the other student no such training. Now give each student the same thought problems. Evidence which we have collected shows that the student who has had the training in method will give a much better answer; because he is conscious that there is a good method to use in solving problems of that particular type and knows what that method is and is able to use it.

3. In the second study, see graph No. 2, there is a greater difference between immediate scores and retention scores than in the first study. Since the average intelligence of the students in the two studies was approximately the same, the time is the only evident variable that might operate to produce this difference in results.

It seems to the writer that no very great benefit can be gained by more group studies of this sort. If such studies are made, much attention must be given to the cases which do not agree with the general conclusions. As a rule there are too many variations of individual cases which are covered up in the general results. Much more will be gained by: (1) a careful analytical study of each individual experiment to determine just what skills and abilities are necessary in mastering that particular exercise; (2) a careful testing, and diagnosis on the basis of evidence obtained by testing, of each individual pupil to see if he has these skills and abilities; and (3) the adoption of such methods and technique for each individual as our study of both experiment and student indicates is best.

OPPORTUNITIES FOR SPECIAL TRAINING FOR SCIENCE TEACHING.

By Lucretia Cressey,
Teachers College, Columbia University, New York.

Since the teachers for the larger high schools usually receive their training in colleges and universities, it seems profitable to determine what opportunities such institutions afford for special training for the teaching of natural science in junior and senior high schools. With this end in view, the recent catalogues and bulletins of fifty-six state universities and other prominent schools were examined for the purpose of determining: first, what courses specifically dealing with high school science teaching are being offered; and second, what is the content of such courses.

This information was available for forty-three state universities and colleges. The other universities whose bulletins were examined are prominent in their own section and many of them are well known throughout the country. In states where there is no state university a special effort was made to determine the offerings of some important school in that state. The report is therefore based upon a complete survey of the offering of professional courses for science teachers in schools of these types in the United States. The following tabulation shows the numbers of courses offered by a single university and the number of schools which the catalogues show are offering that number of courses.

No. of Professional Courses for Science Teachers in Any One School.	No. of State Universities and Colleges Making Such Offering.	No. of Endowed Universities and Colleges Making Such Offerings.
6	2	1
5	2	1
4	4	....
3	5	....
2	9	2
1	14	2
0	7	7

Practically all of these schools, either in the College of Education or School of Education offer courses in high school methods and many of them give opportunities for practice teaching. However, only courses dealing specifically with the teaching of science were noted. Courses treating exclusively of the teaching of physiology, geography, nature study, or elementary science, in grade schools were not listed; nor were courses dealing with the teaching of applied science, such as agriculture or household

arts. A summary of the offerings of the fifty-six universities and colleges shows the following courses for the special training of high school science teachers.:

Courses in the Teaching of:	Offered By:
Physics	23 schools.
Botany	15 "
Chemistry	15 "
Biological Sciences	13 "
Natural Sciences	8 "
Zoology	7 "
General Science	6 "
Physcical Sciences	5 "
High School Geography	3 "
High School Physiology	2 "

The content of the various courses was determined from the descriptions as given in the catalogues and bulletins. The general courses in the teaching of natural science consist of discussions of such topics as—the principles and methods of science teaching in secondary schools; types of science courses and their correlation; and, the measurement of achievement in science work.

Courses for teachers of general science deal with reasons for the introduction of general science; criteria for selection and organization of material; methods of conducting recitations, laboratory periods, and field work; selection of text books; and, the equipment of the laboratory.

Courses designed for the training of botany and zoology teachers include—the history of the introduction of biology into the schools; the aims of the biology teacher; the content and organization of the courses; methods of conducting recitations, laboratory, and field work; testing of results of teaching; comparison of various text books, laboratory manuals, and note books; equipment of the laboratory; and the collection, preparation and preservation of laboratory materials and specimens. Practice teaching is required in a few cases.

A typical course for the training of physics teachers includes: a review of elementary physics with reference to its presentation in laboratory and recitation; a comparison of text books, laboratory manuals, and note books; the purchase, manipulation, and repair of laboratory apparatus.

The importance of chemistry and its place in education is emphasized in the courses for teachers of high school chemistry. Other topics considered are: content and organization; comparison of various methods of presentation; choice of text books and laboratory manuals; the purchase and use of laboratory equipment and apparatus; and the testing of results.

RURAL SCHOOLS NEWS LETTER No. 19.

Summer Schools for Rural Teachers.

Early and partial reports from summer schools at universities, colleges, and normal schools indicate that the enrollment of teachers at these institutions this summer will be larger than ever before. The majority of such institutions offer courses designed to give practical help to teachers in rural schools of all sizes from the one-room to the large consolidated school. Thousands of teachers who expect to teach in country schools next fall will avail themselves of the opportunity for improvement offered. Many school board members and county superintendents when selecting teachers will willingly pay a better salary or add a bonus to the regular salary to the well prepared and to those who have the initiative and ambition to go to summer schools to improve their teaching methods. In the end the children in the schools are the beneficiaries. Country people are willing to pay more for good schools. They should and do wish to know that they are getting value for the increased investment.

This summer is the acceptable time for teachers, school board members county superintendents, and teacher-preparing institutions to co-operate to the end that our country children have better schools next year than they have ever had before. If this co-operation is carried on as effectively as it can be carried on we can have a capable, experienced prepared teacher in every country school.

The President of the United States Speaks for Rural Schools.

Friends of country children and believers in education generally are greatly heartened by the Fourth of July address of the President of the United States delivered before the National Education Association in Washington, D. C. Among other things, the President said that one of the chief rights of an American citizen is the right to an education; that the country, which offers so many advantages denied to those reared on the pavements and among crowded buildings, ought no longer to be handicapped by poor school facilities. "The resources exist," said President Coolidge, "with which they can be provided if they are adequately marshalled and employed." This is the contention that friends of good schools for rural children have long been making. The endorsement of the President of the United States should bring us nearer to our goal.

The Farmer's Interest in the Child Labor Amendment.

Many American farmers will be glad to see the States ratify the child labor amendment because they see in the amendment a means of escape from the ruinous competition engendered by excessive production of many farm commodities. Many farmers who prefer otherwise have been forced to keep their children out of school and use them as a source of labor because so many other farmers with un-American standards of living through exploiting their children have forced down prices to the point where no profit is obtainable except through a source of cheap labor. The farmer knows from bitter experience that the food market is a highly sensitive market. Give a man all he wants to eat and he will pay nothing for a surplus. Put him on short rations and he will pay any price for enough. He has seen this principle verified time and again. The short crop has almost invariably brought the biggest money return, the excessively large crop the smallest money return. When government arbitrarily removes a big surplus labor element those who have real American ideals for their children will hail the act as a god-

send. Many farmers will hail the amendment for what is it, legally enforced co-operation serving the double purpose of protecting children and parents who have real American ideals and of protecting all farmers from excessive competition due to over production as measured by market demands.

American Education Week in the Country.

Profiting by their past experience, many rural teachers too far from libraries and the county superintendent to get direct help with their American Education Week programs are getting information early enough this year so they can intelligently co-operate with public-spirited citizens and organizations in making American Education Week productive of lasting improvement in school betterment. Many such teachers attending summer schools will find much useful material in the normal school libraries; and direct suggestions will be given them, if they request it, by their instructors in school management classes.

County superintendents also are preparing their teachers for better service along this line. In their addresses before summer school audiences and institutes they have an opportunity to show how normal schools and other institutions can perform better service by demonstrating the kind of songs, speeches, slides, pictures, and posters which the teachers next November can profitably use in their programs. Charts and maps depicting conditions existing in the counties of the State in regard to such matters as standardization of rural schools, the growth of consolidation, and the achievements of rural supervision can be used to advantage to arouse school patrons to a greater willingness to spend money on schools.

SOY.

By Dr. Edwin E. Slosson

The recent rise in restaurant prices has sent economical Americans flocking to the chop sueys, where a savory and satisfying meal can still be obtained for a small sum. The Chinese, in their efforts to keep three hundred million people above the starvation point for three thousand years, have been forced to figure closely on food values, and, although they could not tell a calorie from a vitamin at sight, they have worked out some very ingenious dietetic schemes. Especially have they been successful in getting along with little or no meat and milk. With us Americans meat has been the main part of the meal with vegetables on the side. With the Chinese this is reversed, and meat has in many cases been reduced to a condiment. Scraps of beef or pork chopped up in the chop suey or a few shreds of chicken laid on top gives the eaters the illusion of a meat dish. And by using sprouted grain they get the vitamins that are absent in our cereals.

The chief difficulty of a vegetarian diet is to get a sufficient amount and variety of proteins. Beans and peas are the richest in proteins, but they are not of the sort and proportion found in meats and needed for our muscle-making.

But there is one exception and that is the soy-bean. This contains no starch, but carries instead from 30 to 45 per cent of protein, and from 18 to 24 per cent of oil. From this it will be seen that the soy bean resembles animal foods in being rich in fat and protein and devoid of starch. What is more remarkable, the soy bean contains a dozen kinds of protein compounds that are the same as those found in milk. In fact a "vegetable milk" can be made from soy beans and from this vegetable curds and cheese. These form a large part of the diet of Chinese and

Japanese who abstain from animal food either because they are Buddhists or because they are poor. By milking the soy bean they can get ten times as much lacteal fluid per acre as if they pastured cows on the land. Italian physicians who used soy milk as infant food during the war report that it was better tolerated than cow's milk by some of the babies.

The soy milk products have not yet come into use with us, but the American patron of the chop suey has acquired a taste for another product of the bean, the little glass cruet of brown sauce that seasons the rice. It looks and tastes like meat extract, such as we use in making beef tea, and is really much like it in composition and nutritive value. This shoyu or soy sauce is made by long fermentation and ripening of a mixture of beans and wheat in brine. The longer the process the better the product. Six months or a year may suffice for the masses, but to suit the taste of the Oriental connoisseur it must be sunned for five years or even thirty, the jars being patiently uncovered every day and covered every night or whenever it rains. Over two million barrels of soy sauce are made in Japan every year.

The soy bean was first introduced into America in 1804, but it is only within the last ten years that it has come to be commonly raised for oil and cattle food. Now it is becoming one of the major crops in various states. In Ohio at the present rate of increase soy will surpass oats in acreage ten years hence.

But American housewives are slow to admit soy foods to their table in spite of the assurances of C. V. Piper and W. J. Morse of the Department of Agriculture that some eighty palatable and nutritious dishes from soup to dessert can be prepared from the bean. It seems that soy will be as long in fighting its way into popular favor as were potatoes and tomatoes in their day.—[*Science Service.*

READING REFERENCE—Piper, Charles V. and Morse, William J. The Soy bean' New York, McGraw-Hill Book Co., 1923. Year Book of Agriculture, 1917, Washington, Government Printing Office, 1918.

UN-DAMABLE RIVER LED TO CAVERN FIND.

A river that appeared not to be worth a dam was the cause of the geological explorations that resulted in the exploration of the Carlsbad Cavern in New Mexico and in the discovery of its surpassing beauty and extent. The river is the Pecos. Dams built along it for the impounding of water for irrigation purposes had proved to be of little use because the water disappears underground, and so the U. S. Geological Survey, before advising the construction of any more dams, sent Dr. Willis T. Lee to the scene at the request of the Commissioner of Reclamation to find the cause of the river's strange behavior. The result was the real discovery of the Carlsbad Cavern, for although it is nearly twenty miles from the river and without effect upon its course, it became known through Dr. Lee's study of the geology of the whole region and his tracing of strata found in the near vicinity of the troublesome river.

The caverns are in limestone strata 1,300 feet thick, but above and below this layer are other layers of rock salt and gypsum. These were found to be the real trouble makers. The strata are tipped at an angle to the surface, near the river and under it. The gypsum and salt are soluble in water and when the dams were built and the water-level rose beyond a certain point, it dissolved its way through these strata underground and out onto the surface again some miles below the dam.

Tracing the strata back to the foot-hills of the Guadeloupe Mountains, about twenty-two miles southwest of Carlsbad, Dr. Lee rediscovered

for the world the great cavern now made by Presidential proclamation of October 25 a National Monument.

The caverns were first discovered in 1901. Vast numbers of bats we observed issuing from a hole in the side of a hill and exploration revealed a cavern of unknown extent. It remained practically unexplored and unnoticed until this year when Robert A. Holley of the General Land Office surveyed about three and one-half miles of it. Dr. Lee later examined it from the geologic and scenic points of view.

It is, according to Dr. Lee, one of the greatest if not the greatest cavern in the world. Its total length is quite unknown. It extends at least 1,000 feet downwards from the entrance. The formations of stalactites and stalagmites are of extraordinary beauty. One of the "rooms" in the cavern is half a mile long, several hundred feet wide and with a ceiling so high that torches failed to disclose it, their bright beams being lost in the impenetrable gloom.

More remarkable discoveries are likely to be the result of further explorations, Dr. Lee says, since the geologic formations are most unusual. Underneath the limestone layer in which the cave was discovered are beds of gypsum and rock salt of great thickness. These materials are soluble in water, which seeps through and honeycombs them. Dr. Lee believes that in these beds may be sculptured other great caves whose extent and beauty can only be guessed at for the present.

Incidentally, such caverns in salt beds might be developed into mines of incalculable extent and richness. The discovery is considered the biggest in the geological field in recent years, and it all goes back to sending a scientist to find out whether or not the Pecos River is worth a dam. —[*Science Service.*

PLANT EXPERT PUNCTURES EASTER ISLAND MYTHS.

Dr. William E. Safford, economic botanist of the U. S. Department of Agriculture, in a report to the Bishop Museum of Honolulu, has presented plant and linguistic evidence in refutation of many fanciful theories woven about the lonely Easter Island in the South Pacific, erroneously reported to have disappeared following the Chilean earthquake. He traces the kinship of the mysterious inhabitants of this tiny volcanic land with the people of the Malay Archipelago and finds indications that they are of much more recent origin than the various tribes of American Indians.

Easter Island, it has been claimed, was formerly inhabited by a strange race distinct from the natives of Hawaii and the other Polynesian islands. According to Dr. Safford, however, among the plants introduced into Easter Island in prehistoric times there are a number whose vernacular names are identical with the same species in Hawaii and many of them can be traced to the Malay Archipelago, the cradle of the Polynesian race.

Attacking the theory that certain South American Indians are descended from the same race which inhabits Easter Island and that the island was a stepping stone used in the peopling of America, Dr. Safford stated that from the very close similarity of the dialects of widely separated tribes like the Hawaiians, the New Zealanders, and the Easter Islanders, and the identity of many of their myths, their gods, and their calendar systems, it is certain that their separation from one another must have taken place at a very recent time when compared to the very ancient dispersal of the American stocks upon our own continent.—[*Science Service.*

GROWTH OF THE TESTING WORK OF THE BUREAU OF STANDARDS.

An increase of more than one hundred times its initial volume has taken place in the testing work of the Bureau of Standards during the twenty-two years of its existence. During the first fiscal year, that is, up to June 30, 1902, there were completed 1,055 tests of all kinds. During the year just closed about 140,000 tests were conducted by all divisions of the Bureau.

Most of these tests were executed for other branches of the government, practically every branch making use of the facilities provided. The Bureau acts as the principal testing laboratory of the government in the fields of physical science and engineering, and expenditures amounting to many millions of dollars are dependent on its findings. Its tests, which cover a large part of the supplies purchased by the government, serve to insure that these supplies are of the right degree of excellence and in conformity with the specifications.

Much testing is also done for commercial firms and for individuals, over forty thousand test folders, covering over 600,000 such tests, for which a charge is made, having been issued since the founding of the Bureau. The government work is given precedence, however, and in some cases all testing except that for the government has had to be refused because the demand exceeds the facilities for doing the work.

The inability to meet this demand is unfortunate. It is very desirable for the Bureau to carry out certain tests for outside parties, not only as a means of assisting American industries and American citizens, but because the information so gained is of value to the Bureau. It is not to be supposed that the Bureau of Standards has any idea of entering into competition with commercial testing laboratories, but there are certain classes of work which it is considered desirable for it to undertake because the results would be of public benefit.

As a result of the stimulus given to American industry during and following the war, many important industries are now established in this country which did not exist prior to 1914. Many of these are dependent on the Bureau for the testing of their fundamental standards, and in these cases, and indeed in most test work, prompt results are very essential. With the Bureau's present limited facilities considerable delay often results.

TheBureau's experience in the field of scientific and industrial instruments is particularly illuminating. Before the war most high grade scientific instruments were bought abroad and the development of instruments for use in industry was in its infancy. Now, over 85 per cent of the scientific instruments used in the United States are manufactured in this country. There has been a tremendous extension of the use of instruments in all fields of industry. In the meantime the Bureau's facilities for testing these types of apparatus have not been materially increased and the American manufacturers have been greatly handicapped by their inability to get adequate service from the Bureau in developing and testing their instruments. Additional support for this important part of the Bureau's work would bring about increased savings in government expenditures, and would result in higher efficiency in many lines of industry and in better finished products for the public.

In certain lines American manufacturers have been compelled to adopt unsatisfactory substitutes for adequate tests and in some cases they have even had to send instruments abroad and to Canada for test.

The Bureau of Standards itself was established as the result of an

insistent demand that our manufacturers be made independent of other countries for precise measurements, and it is highly desirable that the testing service of the Bureau keep pace with the scientific and industrial development of the country. This testing service is not a severe charge on the Treasury, as fees are charged which practically cover the cost of such tests. The fees, however, are required by law to be returned to the Treasury while an appropriation must be secured to pay for the work.

HELIUM ENOUGH FOR 200 SHENANDOAHS.

There is enough helium gas now available in the United States to keep filled and ready for service 200 airships of the size of the navy dirigible Shenandoah, Dr. Richard B. Moore, former chief chemist of the U. S. Bureau of Mines, told members of the American Institute of Chemical Engineers at their recent Washington meeting. These ships could be kept in the air for five years, he added.

Dr. Moore predicted the building within a few years of airships of twice the size of the Shenandoah, "big enough to carry fuel sufficient for a trip to Europe and return, and with enough reserve buoyancy for a good load of bombs if necessary."

Laws for the conservation of the helium resources of the country will be introduced at this session of Congress, Dr. S. C. Lind, successor to Dr. Moore as chief chemist of the Bureau of Mines, told the delegates. The gas occurs principally as a constituent in the natural gas wells of Texas, and the problem is to separate it from the imflammable part of the natural gas, which may then be used for industrial purposes. There is a great demand for the unseparated natural gas, from which the helium is absolutely lost unless special measures for recovery are taken.

Helium-inflated airships are useless for very long flights unless some method for condensing the water vapor, which is one of the products of combustion of gasoline, is employed. Such a method has been devised. It prevents the ship from getting lighter and lighter, and so having to release helium if it is desired to come to the surface. Rather than lose the valuable gas, the Shenandoah on her recent trip to St. Louis, dove down near the ground and was then pulled to earth by a force of some 300 men, a method which is not always applicable. Dr. Lind said that if 90 per cent of the water vapor could be recovered there would be no loss of weight of the ship.

The purification of helium is also one of the great problems in the industry, Dr. Lind said. The best method is that used in repurification of the gas at the Lakehurst station, where it is passed over activated charcoal at the temperature of liquid air, resulting in the absorption by the charcoal of all gases except helium and hydrogen. This results in nearly 100 per cent helium. Airships are now using a mixture of 90 per cent helium and 10 per cent nitrogen, he said.

Other important sources of helium gas besides the gas wells of the Dallas-Ft. Worth district are known to the government, Dr. Lind stated, but their location and extent are being kept military secrets. When the industry is more developed and the needs of the army and navy are fully met, the surplus supply of the gas will be released for commercial purposes. At present the military uses absorb the entire output.

Dr. Moore during further discussion emphasized the unique military value of helium, saying that this country contains all the known world supply and that as an asset in time of war such a resource is invaluable and should be carefully conserved.—[*Science Service.*

WHY HARDWOODS DO NOT GROW NATURALLY IN THE WEST.

By J. A. Larsen, Forest Examiner.

Excerpts from The Idaho Forster, annual, 1922, 4: 29-32.

Unfortunately the beautiful hardwood trees which are native to the Eastern States do not grow naturally in the West. We have here only aspen, cottonwood, small birch, hawthorns, cherry, and alder. On the Pacific coast are oak and maple, but limited largely to lower moist sites such as streams bed and canyons. The general absence of broad leaf trees in the West is most likely due to the difference in precipitation and temperature between the East and West. To be sure, there are other factors which limit the distribution of trees, such as soil acidity, alkalinity, soil and atmospheric moisture, as well as inherent qualities in the plants themselves. Soil acidity and soil moisture or quality of the soil can at best be of significance only within a limited area, and since it has been shown, except for areas near the sea, that atmospheric moisture varies according to the precipitation, it is only a result and, as such, not a controlling factor. Internal structure of leaves and stems, ability to transport much water, injuries by frost, etc., must be looked upon as direct results of the plant's environment rather than factors which control their distribution. There remains, therefore, the factors of temperture and precipitation and the variation and extremes of these worthy of consideration.

Air temperature, though it may not in all cases be a controlling factor, often limits the distribution of trees either by too short, too cold summer weather and frosts during the growing season, or, by too great extremes. Experiments have shown that the leaves of trees do not become green in temperatures above 104° F. and do not function below 40° F. Unusually low temperatures may cause root killing, bark and wood splitting, and killing of buds and stems of hardwood.

If the growing season is too short, the species which are introduced from a warmer climate bud out too early in the spring, or have no time to form sufficient wood in the new stems to withstand frost injuries in the fall. If the nights are too cold throughout the summer months, one of the plant foods, sugar, which is not injured by freezing, has not had time to form before the cold weather sets in. The plant food is therefore chiefly in the form of starch, which is damaged by frost.

From the standpoint of water requirement of trees, it is well to note that the structure of the leaves, stems, and wood of trees may render some entirely unsuitable for certain climates, especially in regions characterized by dry summer air and low rainfall. Deciduous trees are able to transport much more water than conifers. Dr. Franz R. von Hohnel, of the Austrian Forest Experiment Station, determined by careful tests over a period of 12 years that 1 acre of oak forest lost by transpiration from 2,227 to 2,672 gallons of water per day during periods of growth. This is equal to 2.9 to 3.9 inches of rainfall per month for the growing season—much more than occurs over the western sections of the United States. Other broad-leaved trees are much like oak in respect to evaporation of water.

An examination of the distribution of hardwoods in the Eastern States shows that their general northern limit follows a line through St. Paul, Minn., to Eau Claire and Sheboygan, Wis.; Grand Rapids, Lansing, and Detroit, Mich. North of this line the forest is predominantly coniferous. From Detroit to central New York an inversion occurs in that the hardwoods are on the north and the conifers to the south. This is evidently due to low land and relatively warm air surrounding the

Lakes and the higher land with colder air to the south. From central New York the line goes northeast through western Massachusetts, through Concord, N. H., and Augusta, Me., with conifers on the north and hardwoods to the south. The westward extension of the hardwoods is defined by the Mississippi River from St. Paul to Rock Island, Ill., thence southwestward through Iowa, Kansas, and Oklahoma, irregularly, according to local variations in topography.

In conclusion it may be said that precipitation and atmospheric moisture over the western United States are insufficient for the eastern hardwoods. Air temperature is suitable in most towns and cities and over extensive farming sections. This makes it possible by irrigation or by planting in certain very favorable sites such as moist slopes and aspects sheltered from the driving summer winds, to raise eastern hardwoods in the Pacific Northwest. Except for southern Idaho and the Pacific coast cities, however, the frequent frost which occurs over most of the region during late spring and early fall are a serious drawback, which stunts and kills back the young trees and retards growth on the mature trees.—*Monthly Weather Review.*

BOOK AND PERIODICAL PUBLISHERS WARNED AGAINST USE OF SMALL TYPE.

National Committee for the Prevention of Blindness.

A warning that the extensive use of printing type of smaller dimensions than 10-point is becoming a serious factor among the contributory causes of eye-fatigue and impairment of vision is contained in a communication from The National Committee for the Prevention of Blindness to the various associations of book and periodical publishers, advertisers, printers, school boards, libraries and other large users or producers of printed matter.

The statement calls attention to the fact that, "the use of type smaller than 10-point, not only has a harmful effect on the eyesight of the reader, but often defeats its own purpose by repelling the potential reader who realizes that the reading of such type hurts or tires his eyes." The amount of money lost by advertisers and publishers through the waste circulation that results from the use of type faces difficult to read because of smallness or design, says the National Committee for the Prevention of Blindness, is probably greater than the cost of the extra space and paper stock necessary if larger type is used.

Particularly in the case of school books and other publications read by children is the use of small type harmful, the committee says. Reading matter intended for children of any age should never be printed in type smaller than 10-point. The type sizes recommended for children by the National Committee for the Prevention of Blindness follow:

For children 12 years of age.....10 point
For children between 9 and 12 years....12 point
For children between 8 and 9 years.....14 point
For children between 7 and 8 years.....18 point
For children under 7 years.....24 to 30 point

The publishers of geography and history maps are among the most flagrant offenders in this respect, the committee reports. A special effort to induce publishers of school maps to use larger type will be made.

A research recently conducted by the Department of Education of the State of Ohio showed that certain styles of 24-point type were more easily read by young children than other styles of 36-point type. The ultimate abolition of the use of all 6-point and smaller types of any

styles is urged by the committee. Publishers, printers, and advertisers who have on hand large stocks of such small types are urged to use them only when their use is unavoidable, and to scrap such type at the earliest opportunity.

As an indication of the growing appreciation of the effect of type sizes on eyesight, the National Committee for the Prevention of Blindness reports that at least two public libraries, at St. Louis, Mo., and Springfield, Mass., have set aside departments of "Books for Tired Eyes," in which are included only books of 14 and 18-point type. These books are proving exceedingly popular with older people. Plans are also under way among Bible societies to publish the Book of P salms in larger type for older readers and similar steps are being considered by the publishers of fraternal organization journals, read largely by older persons.

RADIO AND SOUND WAVES USED IN SEA SURVEYING.

A new method of marine surveying using both radio and sound waves has been developed by the U. S. Coast and Geodetic Survey with the co-operation of the U. S. Bureau of Standards, and is now being used in surveys of the Oregon coast. It may be used even in a dense fog and is as accurate as any of the usual methods of sight surveys at sea.

The method depends of the velocity of sound through the sea water which, if known, enables the operator on shipboard to fix his distance from two or more known positions on shore. A simple calculation then permits him to work out his own position. In this method a bomb fired under water near a vessel sends out a sound wave which travels till it reaches an underwater telephone near and connected by cable with a shore radio station. The sound itself by means of suitable apparatus sends back a radio signal to the ship in such a way that, while there is a delay in the return of the signal, this delay can be accurately measured and the result is the same as if there were no delay whatever.

The procedure has been worked out especially for application to surveys to be made along the North Pacific Coast where weather conditions make difficult or even impossible ordinary methods of surveying during a large part of the year. In winter the sea is usually too rough to permit accurate work, while in summer when the sea is smooth, fogs and haze abound, cutting off visibility and making sight surveys impossible much of the time. The Coast Survey steamer Guide is now at work off the Oregon coast, using Marshfield as a base.

As to the accuracy of the method, Commander N. H. Heck, who has been supervising the work, states that at a distance of 10 miles from shore it gives the position of the bomb explosion to within a circle whose diameter is the length of the survey ship. This is accurate enough for the best surveys giving the positions of rocks or other dangers to navigation.

A less accurate modification of the method, cutting out the expensive chronograph on the ship, may be of practical use in navigation. Use of a stop-watch for timing would give an error of at most two-tenths of a second, which would enable a vessel captain to work out his position with sufficient accuracy for ordinary navigation.

As to the distance from shore at which this method of sound ranging is practicable, Commander Heck said that during experimental work in Long Island Sound last fall, a small bomb was distinctly heard at a distance of 55 miles.

MILK FOR HEALTH POSTERS.

As an aid in conducting milk-for-health campaigns, a circular containing reproductions of prize-winning milk posters designed by school children, both city and rural, throughout the country, has just been published by the United States Department of Agriculture. The posters were made in connection with programs carried on by communities in which the children live, with the co-operation of the State Agricultural College and of the Bureau of Dairying in the Federal department.

The aim of an educational milk program is to encourage an intelligent use of milk, for the purpose of improving health and reducing undernourishment. The making of posters has been found a helpful feature, and these reproductions are published with the hope that they may be useful as suggestions to persons planning to conduct similar programs.

Copies of the publication, Miscellaneous Circular 21, Posters Prepared by School Children in Milk-for-Health Programs, may be had free, as long as the supply lasts, by writing to the Department of Agriculture, Washington, D. C.

ARTICLES IN CURRENT PERIODICALS.

American Botanist, Joliet, Ill., for October, *$1.50 a year, 40 cents a copy.* "Meeting Summer Across the Prairie," O. A. Stevens; "Plant Names and Their Meanings"—*XXI Orchidaceae*, Willard N. Clute.; "The Venus Fly-Trap," H. A. Rankin.

American Journal of Botany, Brooklyn Botanic Garden, for October, *$6.00 a year, 75 cents a copy.* "The Effect of Fluctuations in the CO_2 Content of the Atmosphere on the Rate of Respiration of Leaves," H. A. Spoehr and J. M. McGee; "The Pneumathodes on the Roots of the Oil Palm" (*Elaeis guineensis* Jacq.), Cecil Yampolsky; "The Persistency of *Scirpus Validus* Vahl," Frank C. Gates; "Influence of Environal Factors on the Infection of Sorghums and Oats by Smuts I. Experiments with Covered and Loose Kernel Smuts of Sorghum," George M. Reed and James A. Faris; "Does Light Determine the Date of Heading-out in Winter Wheat and Winter Rye?" J. Adams.

American Mathematical Monthly, W. D. Cairns, Oberlin, Ohio, $5.00 a year, 60 cents a copy. "Annual Meeting of the Rocky Mountain Section," Philip Fitch; "Ninth Annual Meeting of the Ohio Section," G. N. Armstrong; "The March Meeting of the Southeastern Section," W. W. Rankin, Jr.; "Integral Inequalities with Applications to the Calculus of Variations," Otto Dunkel; "A System of Triangles Related to a Poristic System," J. H. Weaver; Questions and Discussions: New question 52. Discussions—"Geometrical Construction of Points on a Four-Leaf Rose," H. H. Downing; "Note on the Solution of a Set of Linear Equations," J. P. Ballantine; "Evaluation of the Determinant $[1/(r+s)-1!]$ J. J. Nassau; "On the Division of a Circumference into Five Equal Parts,' H. C. Bradley; "On the Definition of Determinants," A. A. Bennett.

Condor, 514 Lester Ave., Pasadena, Calif., for September-October, *$3.25 a year, 50 cents a copy.* "Anomalies in the Distribution of Fossil Gulls," Loye Miller; "Notes on the Flight Performance of the Wilson Snipe," Ralph Hoffmann; "A Warbler from Nihoa," Alexander Wetmore; "*Branta dickeyi* from the McKittrick Pleistocene" (with four drawings), Loye Miller; "Notes on Some Birds from Tillamook County, Oregon," Alex. Walker; "Fall Migration Notes from the San Francisco Mountain Region, Arizona" (with two photos), Harry S. Swarth.

Education, 120 Boylston St., Boston, Mass., for October, *$4.00 a year, 40 cents a copy.* "Psychology to the Aid of Exposition," Dora Farrington; "Mathematics or Hieroglyphics," A. W. Forbes; "The Normal Curve of Distribution. If Not, Why Not!" Francis L. Cardozo.

Journal of Chemical Education, University of Md., College Park, Md., for September. "Tests of Achievement in Chemistry," S. R. Powers; "Should the Electron Theory Be Included in High School Chemistry?"

Roland B. Hutchins; "The Vapor Density of Steam," W. L. Evans, J. E. Day, C. S. Pease, and G. D. Bland; "Chemical Engineering Education," J. H. James; "Progress of Committee on Chemical Education of the A. C. S.—II"; "Something Done and An Opportunity."

Journal of Geography, 2249 Calumet Ave., Chicago, for September, *$2.50 a year, 35 cents a copy.* "The Continent of Europe," A. E. Parkins; "The Teaching of France," Madeline F. Goodale; "The House and Geography," Frances S. Hay; "A Geography Festival," Cannie Miller and Hattie Harrington; "An Avenue of Approach to the Study of South America," Maude E. Barber.

Monthly Weather Review, Washington, D. C., July. "The Distribution of Thunderstorms in the United States," W. H. Alexander (13 figs.); "Thunderstorms in Ohio During 1917," W. H. Alexander, C. F. Brooks, and G. H. Burnham (7 figs.); "Severe Hailstorm at Rapid City, South Dakota, and Vicinity, July 18, 1924," H. N. Johnson (2 figs.); "The Section on Meteorology of the International Geodetic and Geophysical Union," B. M. Varney.

Nature Magazine, 1214 Sixteenth St., N. W., Washington, D. C., for October, *$2.50 a year.* "Hail and Its Half-Brothers"; "Lions of the Sea"; "Saving the Big Game of Mexico"; "Nils Carlson, Forester"; "Gold That Grows"; "The Texas Bird of Paradise"; "Photographs of Cut-flowers"; "The Otter"; "The Cockroach of the Ages."

Photo-Era, Wolfeboro, N. H., for September, *$2.50 a year, 25 cents a copy.* "Behind the Curtain," Herbert J. Harper; "Photographing Oak Creek Canyon, Arizona," Earl K. Foreman; "Cats and the Camera," Carine Cadby; "Making Greeting-Cards with the Camera," Jones and Howell; "How to Use Gas for Enlarging," Ralph E. Cole; "The Fallacy of the Trimming-Knife," J. Garnett Harper; "The Photographic Expedition to the Grand Canyon," Air Service News Letter; "How to Photograph Moving Objects," Percy B. Prior; "Crowding Prints and How to Avoid It," John B. Roswick; "Photography for the Fourth Estate," Edgar White.

Popular Astronomy, Northfield, Minn., for October, *$4.00 a year, 40 cents a copy.* "Thirty-Second Meeting of the American Astronomical Society," with Plate XIX; "Astronomy at the British Association," C. A. Chant; "Meeting of Astronomers of the Sixth Corps Area," Philip Fox; "The Drift of Jupiter's Markings," with Plate XX, Latimer J. Wilson; "Probability of Cloudiness for the Total Eclipse of the Sun on January 24, 1925," Frederick Slocum; "The Growth of Legend About Sir Isaac Newton," Florian Cajori; "The Altimeter," J. A. Pearce.

School Review, University of Chicago, for October, *$2.50 a year, 30 cents a copy.* "The Trend of Reorganization in Higher Education.—I," Leonard V. Koos; "The High-School Student Handbook," William L. Kershaw and Clarence Herbert Carback; "Present Status of the Junior High School in Cities of More Than 100,000 Population," James M. Glass; "Supervised Study in Wisconsin High Schools," W. W. Brown and J. E. Worthington; "The Effect on High-School Scholarship of Pupil Participation in Extra-curricular Activities," A. M. Swanson.

Scientific Monthly, Garrison, N. Y., for October, *$5.00 a year, 50 cents a copy.* "Rensselaer Polytechnic Institute and the Beginnings of Science in the United States," Ray P. Baker; "The Origin of Life," Charles B. Lipman; "Diseases of Tonsillar Origin," David J. Davis; "Wilhelm Hofmeister," William A. Locy; "Progress in Methods of Inquiry and Research in the Social and Economic Sciences," F. Stuart Chapin; "The Astronomy of Shakespeare," John C. Dean; "The Physical Basis of Disease. III. Tissue Degeneration," The Research Worker; "A Journey in Siberia," T. D. A. Cockerell; "The Boring Habits of the Shipworm," Dr. Robert C. Miller.

Torreya, 2567 Sedgwick St., New York City, for July-August. "Swamp and Bog Plants: *Iris versicolor,*" Frank C. Gates and Elsie Erickson; "Johann David Schöpff, A Pioneer of American Botanical Exploration," Adolph Toepffer; "Proceedings of the Club."

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

831. *H. G. Taylor, San Antonio, Texas.*
832, 833. *Michael Goldberg, Philadelphia, Pa.*
834. *D. L. Mackay, New York, N. Y.*

SOLUTIONS OF PROBLEMS.

836. *Proposed by Richard Lewis, pupil at North East H. S., Kansas City, Mo.*

Volume 1 of "Boys Mechanics" offers a very interesting system of doing multiplication on the fingers. The simplest system deals with numbers between 6 and 10. Let each thumb represent 6, the first finger 7, etc., the last finger representing 10. Then let the fingers representing the numbers to be multiplied touch, using one finger of each hand, the palms facing each other. To find the desired product, add the number of fingers above and including the touching fingers times 10 to the product of the number of fingers below the touching fingers on one hand by the number of fingers below on the other hand.

Prove that the method is correct.

Solved by Michael Goldberg, Philadelphia, Pa.

Let the number x be represented on one hand, and y on the other. Then $x-5$ would be the number of fingers above and including the touching fingers on the hand, and $y-5$ would be the number of fingers on the other. Also $10-x$ is the number of fingers on one hand below the touching fingers, and $10-y$ on the other hand.

According to the rule

$$\begin{aligned} xy &= 10(x-5+y-5)+(10-x)(10-y) \\ &= 10x-50+10y-50+100-10y-10x+xy \\ &= xy \end{aligned}$$

which proves the rule.

Also solved by *J. F. Howard, San Antonio, Tex.*, and the *Proposer.*

837. *Proposed by Archie Blake, '24, Hyde Park H. S., Chicago.*

Given $a+b>c$, $b+c>a$, $c+a>b$.

Prove $2(a^2b^2+b^2c^2+c^2a^2)>a^4+b^4+c^4$.

I. *Solved by John Ankebrant, River Rouge, Mich.*

If $b+c>a$ then $b-a>-c$. Multiplying this inequality by $b+a>c$, we get $b^2-a^2>-c^2$, or

$$b^4-2a^2b^2+a^4>c^4.$$

Similarly $c^4-2b^2c^2+b^4>a^4$ and $a^4-2a^2c^2+c^4>b^4$.

The sum of these three inequalities will reduce to the required one.

II. *Solved by J. F. Howard, San Antonio, Tex.*

$$\begin{aligned} &2a^2b^2+2b^2c^2+2a^2c^2-a^4-b^4-c^4 \\ &\quad = (a+b+c)(a+b-c)(b+c-a)(c+a-b) \end{aligned}$$

According to the hypothesis each of these factors is positive. Hence the product is positive, or

$$2a^2b^2+2b^2c^2+2a^2c^2-a^4-b^4-c^4>0.$$

III. *Solved by D. L. Mackay, New York, N. Y.*

If $b+c>a$, then $b^2+2bc+c^2>a^2$ or $2bc>a^2-b^2-c^2$.

Squaring the last inequality gives

$4b^2c^2>a^4+b^4+c^4-2a^2b^2-2a^2c^2+2b^2c^2$, from which the required one can be found.

Also solved by *Leonard Carlitz, Philadelphia, Pa., George Gatje, Islip, N. Y., Michael Goldberg,* and *C. F. Holmes, Elizabeth City, North Carolina.* The third solution above uses only one of the three relations given in the hypothesis but tacitly assumes (as does also the first solution) that if $x>y$ then $x^2>y^2$ which is not true unless we also assume that y is positive.

The three relations in the hypothesis are satisfied by the three sides of a triangle; hence there should be a geometric derivation and interpretation of the inequality. What is it?

838. *Proposed by Elmer Schuyler, Bay Ridge H. S., Brooklyn, N. Y.*

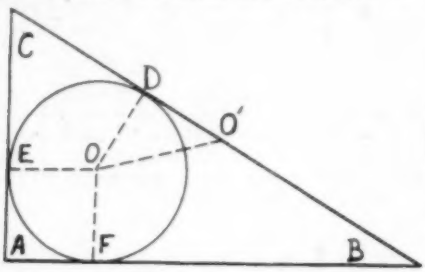
Construct a right triangle given r, the radius of the inscribed circle, and d, the distance between the centers of the inscribed and circumscribed circles.

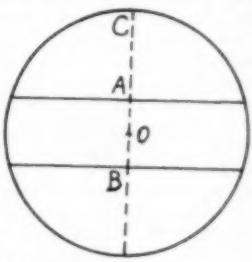
Solved by D. L. Mackay, New York, N. Y.

Let ABC be the required triangle, D the point of tangency of the hypotenuse with the inscribed cricle, O the center of the inscribed circle, O′ the center of the circumscribed circle and R its radius.

From the equation $d^2 = R(R-2r)$ we find $R = r+\sqrt{d^2+r^2}$. Hence R can be found. Construct the right triangle OO′D, knowing its hypotenuse d and one arm r. On O′B, prolonged, measure O′B = R and O′A = R. From A and B draw tangents to the circle O, or find E by using AE = AD and then draw a perpendicular to AE from B.

Also solved by *Leonard Carlitz, J. F. Howard, Michael Goldberg* and *Nelson L. Roray, Metuchen, N. J. Leonard Carlitz* derived a formula for the length of the hypotenuse, and *Michael Goldberg* one for the length of a side. (See Problem 854 proposed in this issue).





839. *Proposed by R. T. McGregor, Elk Grove, California.*

Two parallel planes cut a sphere 12 in. in diameter into three equal volumes. Find the distance between the planes.

Solved by John Ankebrant, River Rouge, Mich

The planes are equidistant from the center of the sphere for the upper and lower segments must be congruent.

The volume of a spherical segment is

$$V = \tfrac{1}{2}a\pi(r_1^2+r_2^2)+\tfrac{1}{6}\pi a^3$$

where r_1 and r_2 are the radii of the bounding planes and a is the distance between the planes. In this problem

$r_1 = r_2 = \tfrac{1}{2}\sqrt{144-a^2}$ and $V = \tfrac{1}{3}\cdot{}^4/_3\,\pi r^3 = 96\pi$.

Hence $a^3-432a+1152 = 0$ or $a = 2.71$

Chas. Oergel, Philadelphia, Pa., retained r in the equation $3s^3-9r^2+4r^3 = 0$ wherein s = OA and showed that the distance between the planes is .226 times the diameter. Several solutions used AC for the unknown and solved $x^3-18x^2+288 = 0$.

Also solved by *Leonard Carlitz, Thomas E. N. Eaton, Redlands, Cal., Michael Goldberg, R. J. Hannelly, Iowa City, Ia., J. F. Howard,* and the following pupils of the *Dickinson H. S., Jersey City, N. J.: Joseph Cussoti, George Turner, George E. Wood.* As an illustration of the good type of advanced work that can be done in high schools we quote the following analysis by *Joseph Cussoti* after deriving the equation $x^3-18x^2+288 = 0$:

"By Descartes Rule there may be two positive roots and one negative

root. But since a negative value of x does not satisfy the problem, the negative root is neglected. By synthetic division one of the positive roots is found to lie between 17 and 18 and the other between 4 and 5. But a value between 17 and 18 will not satisfy the problem. And by Horner's method $x = 4.643$; and AB = 2.714"

840. *For High School Pupils. Proposed by Nelson L. Roray, Metuchen, N. J.*

Prove that $\cos 20° \cos 40° \cos 80° = \frac{1}{8}$

Solved by George Turner, Dickinson H. S., Jersey City.

Let $\cos 20° \cos 40° \cos 80° = k.$

Using the formula $2\cos\alpha\cos\beta = \cos(\alpha+\beta)+\cos(\alpha-\beta)$ this can be written: $\frac{1}{2}\cos 40°(\cos 100° + \cos 60°) = k$ or,

Since $\cos 60° = \frac{1}{2}$: $\frac{1}{4}(2\cos 100° \cos 40° + \cos 40°) = k.$

Using the same formula again, we have:

$\frac{1}{4}(\cos 140° + \cos 60° + \cos 40°) = k$

Using the formula $\cos(\alpha+\beta)+\cos(\alpha-\beta) = 2\cos\alpha\cos\beta$, then $\frac{1}{4}(2\cos 50° \cos 90° + \cos 60°) = k$

As $\cos 90° = 0$, $\cos 60° = \frac{1}{2}$, $\frac{1}{8} = k.$

Also solved by *Joseph Cussoti, Dickinson H. S., Leonard Carlitz, Philadelphia,* and *Murray L. Nolte, Northeast H. S., Kansas City, Mo.*

A solution, which a pupil is not likely to derive is the following:

$\sin 20° = \sin 160°$

$= 2\sin 80° \cos 80°$

$= 2(2\sin 40° \cos 40°)\cos 80°$

$= 4(2\sin 20° \cos 20°)\cos 40° \cos 80°$

$\therefore \quad 1 = 8\cos 20° \cos 40° \cos 80°$

The desirable feature of this solution is that, after the teacher has shown it to the class, the teacher can ask the class to try to find other similar relations by the same method.

PROBLEMS FOR SOLUTIONS.

851. *Proposed by I. N. Warner, State Normal School, Platteville, Wis.*

A creamery employs a man to go out daily to collect cream from the farms. How many pounds of cream testing 35 per cent fat must the man gather each day in order to pay his daily wage of $3, considering that the same price is paid for butter-fat per pound as is received for the butter per pound, namely, 25 cents, and that the "over-run" is 18 per cent:

(a) When cost of manufacture is not considered?

(b) When cost of manufacture is 3 cents per pound for the finished butter?

The "over-run" means the gain in weight by way of salt, water, etc., in the process of making butter. Any given weight of fat, in this case for example, gives 118 per cent of its weight when finished as butter.

852. *Proposed by D. L. MacKay, New York, N. Y.*

Show by an example that two *similar* triangles having two sides of one *equal* respectively to two sides of the other are not necessarily congruent.

853. *Proposed by J. F. Howard, San Antonio, Tex.*

Find the sum of all the products of the first n integers taken three at a time.

854. *Suggested by Problem 838.*

In a right triangle, given the radius r of the inscribed circle and the distance d between the centers of the inscribed and circumscribed circles, find formulas for the sides a and b and the hypotenuse c in terms of d and r.

855. *For High School Pupils. Proposed by Jonas T. May, Mattoon, Ill.*

Within a circle four other equal circles are drawn, each tangent to the large circle and to two of the smaller circles. If the area between the four inner circles is 100 sq. ft., find the radius of each circle.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion.

You are asked to answer questions.

Examination papers are always desired, send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

QUESTIONS FOR SOLUTION.

452. *Suggested by a newspaper clipping.*
(1) What can a horse pull?
(2) Can a horse pull more than its own weight?
(3) Can a locomotive pull more than its own weight?

453. What use are you making of tests in chemistry?

EXAMINATION PAPER.

CHEMISTRY—College Entrance Examination Board.

Saturday, June 21, 1924. 9 a. m.-12 m.

Answer ten questions as indicated below.

Number and letter your answers to correspond to the questions selected.

Credit for the problems on the paper will be given only when the methods of calculation are clearly indicated.

PART I.

(Answer all questions in Part I. Each question counts 10.)

1. Answer four of the following. How could you make (*a*) copper nitrate from copper, (*b*) copper from copper sulphate, (*c*) glucose from starch, (*d*) acetic acid from ethyl alcohol, (*e*) carbon monoxide from carbon dioxide?
2. Write equations for the following reactions using formulas throughout. The equations must be properly balanced to receive credit.
   a) Sodium carbonate and nitric acid.
   b) Hydrogen sulphide burned in an excess of oxygen.
   c) Silver sulphate and sodium phosphate.
   d) Aluminum hydroxide and sulphuric acid.
   e) Sodium in an atmosphere containing moisture and carbon dioxide.
3. *a*) How many grams of sulphur are present in one kilogram of alum, $K_2SO_4.Al_2(SO_4)_3.24H_2O$?
   b) If 0.05 grams of magnesium liberate 0.00413 grams of hydrogen from hydrochloric acid, calculate the chemical equivalent of magnesium.
   (Atomic weights: K 39, S 32, Al 27, O 16, H 1.)
4. How can each of the following substances be identified: sodium chloride, carbon monoxide, nitric acid, sodium hydrogen carbonate, calcium oxide?
5. Indicate the meaning of each of the following terminations when used with chemical names: ic, ous (applied to metals), ide, ite, (applied to salts); also suggest one prefix used with chemical names and indicate its meaning. Illustrate your answer with an example for each, using the names and formulas of particular substances.
6. Describe nitric oxide, giving (*a*) two physical characteristics, (*b*) two chemical characteristics, (*c*) one method of preparation.

PART II.

(Answer four questions from Part II. Answers to extra questions receive no credit. Each question counts 10.)

7. Describe briefly in words a method of preparation for four different

salts: the first by displacement, the second by neutralization, the third by direct combination, the fourth obtained as a precipitate by double decomposition. In connection with each preparation indicate a method for isolating the product.

8. A small flash contains ferric chloride solution (yellow), strongly acidified with hydrochloric acid. A quantity of iron wire is added and the flash closed in such a manner as to permit the escape of gas and to prevent the entrance of air. How do you explain the loss of color? Write an equation for the reaction. On exposure to the air the yellow color of the solution is gradually restored. Account for this change.
9. State what three metallic ions are present in a solution which behaves as follows: when sulphuric acid is added a white precipitate forms which is removed by filtering. Hydrochloric acid is added to the filtrate, whereupon a second white precipitate forms; this is also filtered off and is shown to be soluble in ammonium hydroxide. The filtrate made alkaline gives a third white precipitate with hydrogen sulphide.
10. *a*) Illustrate Gay-Lussac's law of combining volumes with two examples, and show how these volumes may be expressed in the equations for the corresponding reactions.
    b) State briefly two different uses for Avogadro's hypothesis.
11. In the reversible reaction, $2HgO \leftrightharpoons 2Hg + O_2$, which one of the opposing reactions will be aided by (*a*) addition of oxygen, (*b*) removal of mercury, (*c*) increase in temperature? (Heat is absorbed by the decomposition of mercuric oxide.)
12. *a*) Calculate the formula of a gas one liter of which under standard conditions weighs 1.17 grams and which is shown by analysis to contain 92.31 per cent carbon and 7.69 per cent hydrogen.
    b) How many grams of zinc, reacting with dilute sulphuric acid, are required to produce one liter of hydrogen at O°C. and 3040 mm. pressure?
    (Atomic weights: Zn 65, C 12, H 1.)
    22.4 liters of hydrogen at O°C. and 760 mm. weigh approximately 2 grams.)
13. Name one substance useful for each of the following purposes respectively: to disinfect water, to disinfect wounds, to provide the coloring matter in white paint, black paint, red paint, to combat pests in fruit trees, to extinguish fire (not with water), to dry a gas, to catalyze a reaction between gases (state with reaction), to soften hard water.
14. *a*) What is baking soda? Baking powder? Give a specific use for each. Why does baking powder deteriorate when kept in an uncovered box? Should baking powder be mixed with flour before or after the addition of the liquid? Why?
    b) Show by equations how baking soda is made commercially.
15. *a*) Samples of sodium, hydrogen, white phosphorus, hydrogen peroxide, hydrofluoric acid are to be stored. What container would you select for each and what special precautions should be observed in each case?
    b) Indicate briefly the method employed in extracting lead from a sulphide ore.

SOLUTIONS AND ANSWERS.

442. *The old "monkey and rope" problem recently mentioned by Carl Hering, Philadelphia, in* SCIENCE *(Feb. 15, 1924, p. 164).*

A supposedly weightless rope passing over a frictionless pulley has a ten pound weight hanging on one end and a ten pound monkey on the other.

What will happen when the monkey climbs the rope?

(Readers who desire may profitably put this before some lively boys in the form of a "project." Some 100 pound boy may want to try it out against a 100 pound weight.)

Answer from Science.

We are told that the correct answer is that the weight will move up as fast as the monkey and that they will ultimately meet at the top. The monkey, therefore, does twice the work of lifting himself to that height. This is said to have been crudely confirmed by a boy who found it far more difficult to pull himself up in such a case than when the top of the rope was immovably secured.

It seems necessary to distinguish between a jerky and a uniform movement of the monkey; the former involves acceleration, deceleration and inertia. It is claimed that with a uniform motion the weight would not move, as the monkey can not pull with a greater force than his weight. And that with a jerky upward motion of the monkey, involving acceleration and deceleration, the weight would move up and down for each jerk, but its average and ultimate position would remain the same. Others claim that the weight would move up with every jerk, but would not descend again during the deceleration, hence its ultimate upward motion would be equal to that of the monkey. A spring or elastic rope introduces another complication.

(NOTE—It is distinctly disappointing that in these days of adherence to the "project" method, none of our readers felt that such a project as this was worth trying and reporting upon.)

443. *Proposed by J. W. Wilbur, Peoria, Ill.*

If a cork is floated in a bottle partly filled with water and then air is pumped in under high pressure, will the cork rise higher or sink deeper in the water, or neither? (It is assumed, I suppose, that air does not penetrate the cork, and that its volume remains constant.)

Solution by J. E. Running, Central High School, Fargo, North Dakota.

If air does not penetrate the cork and its volume remains constant it will rise higher. As the pressure is increased the density of the air is increased, and slightly also the density of the water. This will increase the buoyancy and make it rise higher.

445. *Proposed by E. A. Rae, San Jose, Cal.*

Given two equal quantities of two liquids which have different specific gravities but which are capable of mixing with each other by diffusion. (For example, the liquids in a gravity cell.) Suppose them placed carefully in a cylindrical jar, with the heavier liquid below. The geometric volumes occupied by the two liquids are congruent. The center of gravity of the two liquids regarded as a whole lies on a line joining the individual centers of gravity, and at a point which divides this line into segments proportional to the specific gravities of the liquids. Evidently this point is below the horizontal plane separating the liquids. Now let diffusion take place. After the mixture has come to the same specific gravity throughout, the center of gravity will be in the horizontal plane which formerly separated the two liquids. That is to say, the center of gravity has been raised. Raising the center of gravity is equivalent to raising the entire mass. Whence came the energy to do this work?

Answer suggested by E. A. Rae.

There MUST be a definite lowering of temperature accompanying diffusion. This temperature drop should be susceptible of computation through the specific heats and the specific gravities of the two liquids and the mechanical equivalent of heat.

448. *Proposed by Fred S. Jones, Hastings, Mich.*

How silver a mirror without using ethyl alcohol?

Answer by Mr. Wm. Gaertner, The Gaertner Scientific Corporation, Scientific Instruments, Chicago.

Glass Cleaning for Silvering.

Before silvering the plate must be thoroughly cleaned. The following method is recommended:

1. If any wax or oil is on the glass dissolve with spirits of turpentine. Do not use unless necessary.
2. Dissolve silver with nitric acid.
3. Wash well with a strong solution of caustic potash. It is best to rub

with swab of clean cotton tied to a piece of glass rod or a piece of gum tubing on the end of the rod, being careful not to scratch the optical surface.

4. Wash well with nitric acid.
5. Wash well with distilled water.

In operation 4 and 5 use same swab as used in 3. Between each of above operations rinse thoroughly with distilled water.

Silvering Solutions.

Rochelle Salt Method.

Solution A. Silver nitrate, 5 grams; water, 40cc.

When dissolved add ammonia until precipitate is nearly redissolved. Dilute to 500cc. with distilled water and filter.

Solution B. 1 gram silver nitrate is dissolved in a little water and added to 500 cc. of boiling water. Add 0.83 grams Rochelle Salt (sodium, potassium, tartrate). Boil for a few minutes (5-10) and filter hot.

The last of the ammonia must be added *drop by drop*, being very careful not to allow the precipitate to entirely dissolve. In case the latter occurs add a few drops of silver solution the same strength as the original until coloration appears.

When ready to silver use equal parts of A and B, place the glass in a shallow dish and pour over it the mixed solution. Rock the dish gently until the silvering is nearly complete. Ten to twenty minutes is usually required for a good coat. *The glass to be silvered must be thoroughly cleaned.* If the solutions are more than two weeks old they do not give a sufficient coating of silver for transparent films. If, however, both solutions are warmed to 36 to 40 degrees Cent. and allowed to cool they will be found to deposit as well as fresh solutions.

This method is best for semi-transparent films.

Cleanliness is the element of success in silvering a mirror.

Clark's Method.

Clean with nitric acid, Chloride of tin, tablespoonful to bowl of water.

Silver Solutions: 10 grains silver to each ounce of water, add ammonia and clear fully.

Reducing Solutions: 20 minums of Formaldahyde (Merk's) for each 10 grains of silver solution, dilute in five times amount of water.

PUCKERLESS PERSIMMONS.

Persimmons are scheduled for a rise in popularity. At last, a persimmon has been found which will not pucker the mouth no matter how green it is when eaten. It is the Fuyu persimmon which the U. S. Department of Agriculture has introduced from Japan and predicts will become one of our leading varieties. The Fuyu has a beautiful golden orange color, is ideal for shipping, and what is more to the taste, is never astringent and can be eaten with enjoyment even when still hard.

Irregular school attendance caused the waste of $250,000,000, one-quarter of the money spent for public education in the United States in 1923, according to statisticians of the United States Bureau of Education. The people who paid the taxes robbed themselves of this amount and at the same time deprived their own children of an average of two-months schooling.

More than 22,000,000 children were enrolled in the public schools of the country and the schools were open an average of about eight months. Nearly 700,000 teachers were employed and that number was sufficient to instruct every child enrolled every school day of the eight months the schools were in session, say the Bureau of Education officials. The total cost in all the States combined was about one billion dollars. By allowing their children to miss school one-quarter of the time parents caused the waste of one-quarter of the money paid to run the schools.

DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March and November issues of this Journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. This is extremely valuable information to all progressive teachers. Is your society listed here? Names are dropped when they become one year old.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

President, J. McKeen Cattell, Garrison-on-Hudson, N. Y.; *Vice Presidents and Secretaries of Sections:*

Section A (Mathematics). J. C. Fields, *Vice President;* University of Toronto, Toronto, Ont., Canada; William H. Roever, *Secretary;* Washington University, St. Louis, Mo.

Section B (Physics). E. F. Nichols, *Vice President;* Nela Research Laboratory, Cleveland, Ohio; S. R. Williams, *Secretary;* 154 Forest St., Oberlin, Ohio.

Section C (Chemistry). W. F. Hillebrand, *Vice President;* 3023 Newark St., Washington, D. C.; W. D. Harkins, *Secretary;* University of Chicago, Chicago, Ill.

Section D (Astronomy). John A. Miller, *Vice President;* Swarthmore College, Swarthmore, Pa.; F. R. Moulton, *Secretary;* University of Chicago, Chicago, Ill.

Section E (Geology and Geography). W. C. Mendenhall, *Vice President;* U. S. Geological Survey, Washington, D. C.; E. S. Moore, *Secretary;* University of Toronto, Toronto, Ont., Canada.

Section F (Zoological Sciences). Edwin Linton, *Vice President;* 1104 Milledge Road, Augusta, Ga., H. W. Rand, *Secretary;* Harvard University, Cambridge, Mass.

Section G (Botanical Sciences). G. R. Lyman, *Vice President;* University of West Virginia, Morgantown, W. Va.; Robert B. Wylie, *Secretary;* State University of Iowa, Iowa City, Iowa.

Section H (Anthropology). E. A. Hooton, *Vice President;* Peabody Museum, Cambridge, Mass. R. J. Terry, *Secretary;* Washington University Medical School, St. Louis, Mo.

Section I (Psychology). R. S. Woodworth, *Vice President;* Columbia University, New York, N. Y.; Frank N. Freeman, *Secretary;* University of Chicago, Chicago, Ill.

Section K (Social and Economic Sciences). Thomas S. Baker, *Vice President;* Carnegie Institute of Technology, Pittsburgh, Pa.; Frederick L. Hoffman, *Secretary;* Babson Institute, Wellesley, Mass.

Section L (Historical and Philological Sciences). L. C. Karpinski, *Vice President;* University of Michigan, Ann Arbor, Mich.; Frederick E. Brasch, *Secretary;* Carnegie Institution, Washington, D. C.

Section M (Engineering). A. E. Kennelly, *Vice President;* Harvard University, Cambridge, Mass.; L. W. Wallace, *Secretary;* 26 Jackson Place, Washington, D. C.

Section N (Medical Sciences). William A. MacCallum, *Vice President;* Johns Hopkins University, Baltimore, Md.; A. J. Goldfarb, *Secretary;* College of the City of New York, New York, N. Y.

Section O (Agriculture.) L. R. Jones, *Vice President;* University of Wisconsin, Madison, Wis.; P. E. Brown, *Secretary;* Iowa State College, Ames, Iowa.

Section Q (Education). L. A. Pechstein, *Vice President;* University of Cincinnati, Cincinnati, Ohio.; A. S. Barr, *Secretary;* 1924 Hazelwood, Detroit, Mich.—1223.

AMERICAN ASTRONOMICAL SOCIETY.

President, W. W. Campbell, Mt. Hamilton, Calif.; *Vice Presidents*, Ernest W. Brown, New Haven, Conn.; *Secretary*, Joel Stebbins, Madison, Wis.; *Treasurer*, Benjamin Boss, Albany, N. Y.—823.

AMERICAN MATHEMATICAL SOCIETY.

Vice Presidents, Prof. E. V. Huntington, Harvard University; Prof. T. H. Hildebrandt, University of Michigan; Prof. J. H. M. Wedderburn,

"THE SCIENCE CLASSROOM"

A Magazine for

SCIENCE TEACHERS

The Science Classroom supplements the textbook and provides the stimulating, vitalizing interests that make for successful science teaching.

It describes the classroom methods, practices and experiences of the most successful science teachers in different parts of the country.

It illustrates apparatus constructed and tried out in the classroom.

It gives detailed directions for extra-curricular activities.

It publishes lists of books, apparatus and materials.

September-June, 10 issues, 25 cents.

POPULAR SCIENCE MONTHLY

Is used in thousands of schools as a supplemental science reader. It is recognized as the best source of material for outside reading and class discussion for Junior and Senior High School Classes.

Regular price—$2.50 a year.

Special Rate to Schools $1.75 a year.

Educational Department,
244 Fourth Avenue,

Popular Science Monthly.
New York, N. Y.

One of the most pronounced evidences of the appreciation in which the value of School Science and Mathematics is held is the great number of orders received for the entire set of back numbers. Let us have your order.

Dependable and worth while

BIOLOGICAL SUPPLIES

Large stock of material in Zoology, Botany, Life Histories and Microscope slides.

For the student, the class room, the museum.

New Zoological and Life History Catalogs.

Catalogs free, Zoology, Life Histories, Botany, Microscope slides.

The world renowned.

Supply Department

MARINE BIOLOGICAL LABORATORY

GEORGE M. GRAY, Curator

Woods Hole, Mass.

Princeton University; *Secretary*, Prof. R. G. D. Richardson, Brown University; *Assistant Secretary*, Prof. Arnold Dresden, University of Wisconsin; *Treasurer*, Prof. W. B. Fite, Columbia University; *Librarian*, Prof. R. C. Archibald, Brown University; *Member of the Editorial Committee of the Bulletin*, Prof. Arnold Dresden, University of Wisconsin. —1223.

AMERICAN METEOROLOGICAL SOCIETY.

President, Willis I. Milham, Williams College, Williamstown, Mass; *Vice President*, A. E. Douglass, University of Arizona, Tucson, Ariz.; *Secretary*, Charles F. Brooks, Clark University, Worcester, Mass.; *Treasurer*, Willis Ray Gregg, Weather Bureau, Washington, D. C.—1223.

AMERICAN NATURE STUDY SOCIETY.

President, M. R. Van Cleve, Toledo, Ohio; *Vice Presidents*, J. A. Drushel, St. Louis; Theodosia Hadley, Kalamazoo; W. G. Vinal, Providence; Mrs. J. D. Sherman, Chicago; *Directors*, E. R. Downing, Chicago; W. F. Heilman, Columbus; E. E. Balcomb, Arcata, Calif.; H. F. Brode, Walla Walla, Wash.; G. F. Trafton, Mankato, Minn.; A. F. Satterthwait, Webster Groves, Mo.; L. Lenore Conover, Detroit, Mich.; *Editor and Secretary*, Anna Botsford Comstock, Ithaca, N. Y.—1223.

AMERICAN PHYSICAL SOCIETY.

President, C. E. Mendenhall, University of Wisconsin; *Vice President*, D. C. Miller, Case School of Applied Science; *Secretary*, H. W. Webb, Columbia University; *Treasurer*, G. B. Pegram, Columbia University; *Editor*, G. S. Fulcher, Corning, N. Y.; *Local Secretary for the Pacific Coast*, D. L. Webster, Stanford, University.—1223.

AMERICAN SOCIETY OF AGRONOMY.

President, M. F. Miller, Agr. Expt. Sta., Columbia, Mo.; *Secretary-Treasurer*, Percy Edgar Brown, Iowa State College, Ames, Iowa.; *Editor*, R. W. Thatcher, N. Y. Agr. Expt. Sta., Geneva, N. Y.; *Executive Committee*, W. L. Burlison, Urbana, Ill.; Clyde McKee, Bozeman, Mont.; S. B. Haskell, Amherst, Mass.; C. A. Mooers, Knoxville, Tenn.—1223.

AMERICAN SOCIETY OF NATURALISTS.

President, Prof. W. H. Howell, Johns Hopkins University, Baltimore; *Vice President*, Prof. Lester W. Sharp, Cornell University, Ithaca, N. Y.; *Secretary*, Prof. A. Franklin Shull, University of Mich., Ann Arbor, Mich.; *Treasurer*, Dr. J. Arthur Harris, Carnegie Institution, Cold Spring Harbor, Long Island, N. Y.

AMERICAN SOCIETY OF ZOOLOGISTS.

President, Ross G. Harrison, Yale University; *Vice President*, R. K. Nabours, Kansas State Agricultural College; *Secretary*, W. C. Alen, University of Chicago; *Treasurer*, Robert H. Bowen, Columbia University.—1223.

ASSOCIATION OF AMERICAN GEOGRAPHERS.

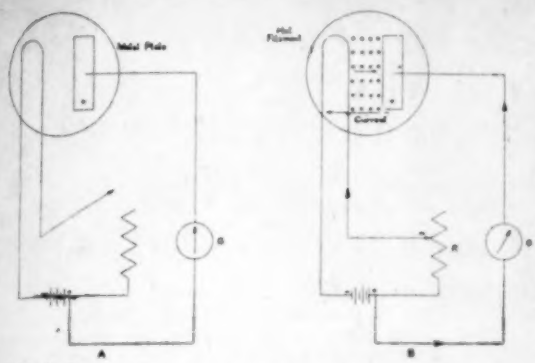
President, C. F. Marbut, Bureau of Soils, Washington, D. C.; *Secretary*, Prof. C. C. Colby, University of Chicago, Chicago, Ill.; *Treasurer*, Prof. Vernor C. Finch, University of Wisconsin, Madison, Wis.; *Editor*, Professor Almon E. Parkins, George Peabody College for Teachers, Nashville, Tenn.—1223.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

President, Clarence L. Holtzman, Waller High School, Chicago; *Vice-President*, T. D. Kelsey, Cleveland High School, St. Louis; *Treasurer*, W. G. Gingery, Shortridge High School, Indianapolis; *Secretary*, Glen W. Warner, Englewood High School, Chicago; *Assistant Treasurer*, M. C. Davis, Univ. High School, Madison, Wis.; *Corresponding Secretary*, Katherine Ulrich, High School, Oak Park, Ill. Next meeting, November 28 and 29 at Senn High School, Chicago.

ASSOCIATION OF TEACHERS OF MATHEMATICS IN NEW ENGLAND.

President, A. Harry Wheeler, North High School, Worcester; *Vice President*, Prof. Lennie P. Copeland, Wellesley College; *Secretary*, Harry D. Gaylord, Browne and Nichols School, Cambridge, 20 Charlesgate West, Boston; *Treasurer*, Harold B. Garland, High School of Commerce, Boston; Prof. George D. Birkhoff, Harvard University; Miss Annie F. Doughty, Dana Hall Wellesley; Prof. J. W. Young, Dartmouth College;



©K. V. Co.

Fleming's Explanation of the Edison Effect.

TEACH RADIO

With

KEYSTONE LANTERN SLIDES

The Romance of Radio

By F. G. Taylor, Oregon, Illinois.

Covers the history and fundamental principles of radio in seventy-five lantern slides with accompanying descriptive text.
It will add immensely to the interest in the study of this important subject.
It will strengthen immensely the pupils' interest in the whole subject of magnetism and electricity.
It will enable the busy teacher to teach more in less time than can otherwise be done.
Title list and further information will be furnished on request.
If you do not have a good lantern, send for descriptive circular of the Keystone Daylight Projection Lantern.

Keystone View Company, Inc.
Meadville, Pa.

REVIEW QUESTIONS

Twelve Thousand Questions in Eighteen Booklets

Algebra	**Plane Geometry**
Chemistry	**Solid Geometry**
Physics	**Trigonometry**

Six Pamphlets by Franklin T. Jones

French Grammar Review—American History and Civics—Ancient History

Three Pamphlets just published—compiled by Expert Teachers

Other Pamphlets

French A, French B; German A, German B; First Latin, Second Latin; Medieval and Modern European History (including English History); Question Book on History; English.

Price, each pamphlet, 50c. except English, Second Latin and French Grammar Review, 60c. Sample copy to a teacher half-price when money is sent with the order.

Liberal discounts for Class Use

Published and for Sale by

THE UNIVERSITY SUPPLY & BOOK CO.

10109 Wilbur Ave., Cleveland, Ohio.

Charles H. Mergendahl, Newton Classical High School; Harry C. Barber, English High School, Boston; Miss Olive A. Kee, Boston Normal School.—1223.

ENGINEERING EDUCATION.

President, P. F. Walker, University of Kansas, Lawrence, Kan.; *Vice Presidents*, H. S. Boardman, University of Maine, Orono, Me.; O. J. Ferguson, University of Nebraska, Lincoln, Nebr.; *Secretary*, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.; *Treasurer*, W. O. Wiley, New York City.

ENTOMOLOGICAL SOCIETY OF AMERICA.

President, Arthur Gibson, Dominion Entomologist, Ottawa, Canada; *First Vice President*, W. A. Riley, University of Minnesota, St. Paul, Minn.; *Second Vice President*, R. A. Cooley, Agricultural Experiment Station, Bozeman, Mont.; *Secretary-Treasurer*, C. L. Metcalf, University of Illinois, Urbana, Ill.; *Managing Editor of Annals*, Herbert Osborn, Ohio State University, Columbus, Ohio.—123.

ILLINOIS STATE ACADEMY OF SCIENCE.

President, Dr. W. G. Bain, Springfield; *Vice President*, Charles H. Smith, Hyde Park High School, Chicago; *Secretary*, C. Frank Phipps, State Teacher's College, DeKalb; *Treasurer*, W. B. McDougall, Urbana; *Librarian*, A. R. Crook, State Museum, Springfield; *Chairman Membership Committee*, B. K. Richardson, Springfield.—324.

IOWA ACADEMY OF SCIENCE.

President, O. H. Smith, Cornell College; *Vice President*, R. I. Cratty, State College; *Secretary*, P. S. Helmic, Drake University; *Treasurer*, A. O. Thomas, State University; *Representative to A. A. A. S.*, D. W Morehouse, Drake University. *Chairmen of Sections*, Bacteriology, Paul Emerson, State College; Botany, H. E. Jaques, Iowa Wesleyan College; Chemistry, H. F. Lewis, Cornell College; Geology, W. F. V. Leicht, Simpson College; Mathematics, E. R. Smith, State College; Physics P. S. Helmick, Drake University; Zoology, Dayton Stoner, State University.—824.

KANSAS ACADEMY OF SCIENCE.

President, H. P. Cady, Lawrence, Kan.; *Vice President*, H. H. Nininger, McPherson, Kan.; *Second Vice President*, J. E. Ackert, Manhattan, Kan.; *Treasurer*, L. D. Havenhill, Lawrence, Kan.; *Secretary*, E. A. White, Lawrence, Kan.; *Executive Committee*, R. K. Nabours, Manhattan, Kan.; R. U. G. Agrelius, Emporia, Kan.; W. A. Harshbarger, Topeka, Kan.; J. T. Willard, Manhattan, Kan.—1223.

KENTUCKY ACADEMY OF SCIENCE.

President, Willard R. Jillson, Kentucky Geological Survey, Lexington; *Vice President*, Dr. Austin R. Middleton, University of Louisville; *Secretary*, Dr. Alfred M. Peter, Kentucky Agricultural Experiment Station; *Treasurer*, W. S. Anderson, University of Kentucky.—423.

MATHEMATICAL ASSOCIATION OF AMERICA.

President, Prof. H. L. Rietz, University of Iowa, Iowa City, Iowa; *Vice Presidents*, Prof. J. L. Coolidge, Harvard University, Cambridge, Mass.; Prof. Dunham Jackson, University of Minnesota, Minneapolis, Minn.; Prof. R. D. Carmichael, University of Ill., Urbana, Ill.; *Trustees*, Prof. E. R. Hedrick, University of Mo., Columbia, Mo.; Prof. D. E. Smith, Teachers' College, Columbia University, New York, N. Y.; Prof. E. J. Wilczynski, University of Chicago, Chicago, Ill.; Dr. A. B. Chace, Brown University, Providence, R. I.; *Secretary-Treasurer*, Prof. W. D. Cairns, Oberlin, College, Oberlin, Ohio; *Librarian*, Prof. R. B. McClenon, Grinnell College, Grinnell, Iowa.—1223.

MICHIGAN STATE ACADEMY.

President, Campbell Bonner; *Secretary-Treasurer*, L. R. Dice; *Librarian*, W. W. Bishop; *Editor-in-Chief*, P. S. Welch.—323.

NATIONAL COUNCIL OF GEOGRAPHY TEACHERS.

President, W. R. McConnell, Miami University, Oxford, Ohio; *Vice President*, Frederick K. Branom, Chicago Normal Couege, Chicago, Ill.; *Vice President*, Julia M. Shipman, State Normal School, New Britain, Conn.; *Secretary*, George J. Miller, State Teachers College, Mankato,

The Twenty-fourth Meeting of the Central Association of Science and Mathematics Teachers

Nicholas Senn High School, Chicago
November 28 and 29

At the meeting of the Association the relation of science and mathematics in the junior and senior high schools will be discussed.

The steady and rapid development of junior high schools over the country give us good reason to take stock of our attitude so as not to be left stranded in the eddies left by the tide of progress.

If you are progressive the Association needs you, if you are conservative you need the stimulus of the meeting.

Miss Marie Gugle, assistant superintendent of schools, Columbus Ohio, will speak Friday morning on "Mathematics of the Junior High School." Dr. George W. Hunter of Knox College will give the results and conclusions of his recent investigation on "The Sequence of Science in the High Schools of Today."

Dr. E. E. Slosson, Director of Science Service, Washington, D. C., has been asked to be the principal speaker of the morning. Dr. Slosson is widely known as the author of Creative Chemistry, Science Remaking the World, etc.

Dr. Fay-Cooper Cole who headed the Field Museum expedition to Malasia will speak at the dinner in the evening. His subject "Where East Meets West," will give a most interesting account of his experiences in the Malay Peninsula.

Very attractive programs have been built for the section meetings Friday afternoon. Dr. Douglas Singer, author and psychiatrist will show the need of grappling with the problem of the feeble minded.

Dr. Haas, Northwestern University speaks on "The Indian Tribes of South America."

"The Biological Station in the Canal Zone" is the topic of Dr. W. C. Allee, University of Chicago.

"General Science, Past, Present and Future," will be discussed by Earl Glenn of Columbia.

Mr. John T. Johnson of Chicago Normal College will present the subject "Geometry in Junior High Schools." Does this mean that the senior high will have only trigonometry and calculus? What of the college?

Dr. Elliot Downing will speak at the all science meeting Saturday morning on "The Unification of Courses Through Grades Seven to Fourteen," linking junior and senior high schools with junior colleges.

Programs will be mailed about November 7th. If you wish one send your name and address to

MISS MARY PARDEE
917 Forest Avenue Evanston, Ill.

Minn.; *Treasurer*, Douglas C. Ridgley, Clark University, Worcester, Mass.; *Board of Directors*, Jane K. Atwood, State Normal School, Emporia, Kan.; G. A. Barker, State Teachers' College, Greeley, Colo.—1223.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

President, S. Walter Hoyt, Mechanic Arts High School, Boston, Mass.; *Vice President*, J. Herbert Ward, Classical High School, Providence, R. I.; *Secretary*, Laurence R. Atwood, Malden High School, Malden, Mass.; *Treasurer*, Alfred M. Butler, High School of Practical Arts, Boston, Mass.; *Curator*, Lyman C. Newell, Boston University, Boston, Mass.; *Assistant Secretary*, Octaria Chapin, Malden High School, Malden, Mass.; *Chairman Western Division*, Leslie O. Johnson, New Haven High School, New Haven, Conn.; *Chairman Southern Division*, Herbert F. Davison, Brown University, Providence, R. I.; *Chairman Central Division*, Eva Ammidown, Jamaica Plain High School, Boston, Mass.; *Chairman Northern Division*, Myron E. Berry, Tilton Seminary, Tilton, N. H. —1223.

NORTH CAROLINA ACADEMY OF SCIENCE.

President, Dr. A. Henderson, University; *Vice President*, Dr. H. B. Arbucles, Davidson College; *Secretary-Treasurer*, Dr. Bert Cunningham, Trinity College.—532.

OHIO ACADEMY OF SCIENCE.

President, K. F. Mather, Denison University, Granville, Ohio; *Vice Presidents*, W. M. Barrows, Ohio State University, Columbus, Ohio; H. H. M. Bowman, Toledo University, Toledo, Ohio; J. E. Carman, Ohio State University, Columbus, Ohio; W. C. Devereaux; B. M. Patten, 1353 E. Ninth Street, Cleveland, Ohio; H. A. Aikins, College for Women, Cleveland, Ohio; *Secretary*, Wm. H. Alexander, U. S. Weather Bureau, Columbus, O.; *Treasurer*, A. E. Waller, Ohio State University, 16 E. Broadstreet, Columbus, O.—1223.

OPTICAL SOCIETY OF AMERICA.

President, Herbert E. Ives, 463 West Street, New York City, N. Y.; *Vice President*, W. E. Forsythe, Nela Research Laboratories, Nela Park, Cleveland, Ohio,; *Secretary*, Irwin G. Priest, Bureau of Standards, Washington, D. C.; *Treasurer*, Adolph Lomb, Bausch and Lomb Optical Company, Rochester, N. Y.; *Members of the Executive Council*, above officers; *Past President*, Leonard T. Troland, Emerson Hall, Harvard University, Cambridge, Mass.; *Editor-in-Chief of the Journal*, Paul D. Foote, Bureau of Standards, Washington, D. C.; *Assistant Editor-in-Chief and Business Manager of the Journal*, F. K. Richtmyer, Cornell University, Ithaca, N. Y.—1223.

PALEONTOLOGICAL SOCIETY.

President, E. W. Berry, Baltimore, Maryland, Johns Hopkins University; *First Vice President*, E. H. Barbour, Lincoln, Nebraska, University of Nebraska; *Second Vice President*, Frank Springer, Washington, D. C., United States National Museum; *Third Vice President*, F. M. Anderson, Berkeley, California, 2604 Etna Street; *Secretary*, R. S. Bassler, Washington, D. C., United States National Museum; *Treasurer*, Carl O, Dunbar, New Haven, Conn., Yale University; *Editor*, Walter Granger, New York City, American Museum of Natural History.

SOUTHERN CALIFORNIA SCIENCE AND MATHEMATICS ASSOCIATION.

President, Dr. Leroy S. Weatherby, University of Southern California; *Vice President*, Miss Laura E. Liddle, Santa Monica High School; *Secretary-Treasurer*, Miss Grace M. R. Abbot, Venice High School. *Section officers for 1923: Mathematics—Chairman*, W. A. Bartlett, Junior College, Pomona, Calif.; *Secretary*, George S. Johnstone, Hollywood High School, Los Angeles, Calif; *Earth Science—Chairman*, H. M. Werre, High School, Alhambra, Calif.; *Secretary*, Miss Bernice Ogden, Lincoln Junior High School, Santa Monica, Calif. *Biology—Chairman*, Alfred Cookman, Polytechnic High School, Los Angeles, Calif.; *Secretary*, Miss Eunice Munson, Lincoln High School, Los Angeles, Calif.; *Physics-Chemistry—Chairman*, Miss Isabelle Willson, Manual Arts High School, Los Angeles, Calif.; *Secretary*, C. W. Gray, Hollywood High School, Los Angeles, Calif.—323.

WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

President, Leon J. Cole, Madison. *Vice Presidents*, Sciences, S. A. Barrett, Milwaukee; Arts, H. E. Cole, Baraboo; Letters, Arthur Beatty, Madison. *Secretary-Treasurer*, Chancey Juday, Madison.—424.

CHEMISTRY
IN
EVERYDAY LIFE
1924

EMERY-DOWNEY-DAVIS-BOYNTON

FINAL EDITION NOW OFF THE PRESS

Loose-Leaf Manual to accompany

A text which carries material for minimum and maximum requirements, so arranged that it is actually usable.

Fundamental Principles for the minimum course are covered in the first 393 pages. 267 pages of additional material are supplied for special assignment, reading, and study.

Use of Equation from the first lesson throughout the course both in the use of words and formulas.

Standard spelling of all terms.

Formulas are the same as those used in up-to-date texts in Algebra and other correlated subjects.

Tables, numerous and adequate, sixty-five in all.

Cross references throughout.

Applied Chemistry. Treatment of special topics as follows in last 267 pages: Foods, Clothing, Fuel, Illumination, Agriculture, Soap, Paper, Ink, Leather, Sanitation, Medicines, Patent Medicines, Poisons, Chemical Warfare, etc.

The Introductory Edition of This Text Met with Such Instant Approval as to Secure Adoptions in Seventy-five Prominent Cities of the Country and One State Adoption.

LYONS AND CARNAHAN

Publishers

CHICAGO **NEW YORK**

ASTRONOMICAL MIST CLEARED BY MATHEMATICS.

The mystery of nebulium, the strange gas supposed to exist in comets, nebulae, and certain stars, is being dissipated. Prof. Harvey B. Lemon of the University of Chicago has made discoveries which indicate that there is probably no such element in the universe and what has been taken for it is merely helium in disguise.

Spectroscopists, who detect the make-up of stars and other things by analyzing the light which comes from them, have long been worried by lines in the nebular spectra, which did not agree with those of any substance known on earth. A bright green line was especially characteristic. These strange lines have been attributed to an unknown element of light atomic weight which was called "nebulium" after the nebulae in which they were found. Ideas about nebulium have, however, become even more nebulous; for modern work in physics and chemistry seem to indicate that there could be no light weight element not already known.

In addition to the so-called nebulium lines, most of the nebulae show the well known lines characteristic of hydrogen and helium. Thinking that one or both of these elements might possibly cause the lines of nebulium, Prof. Lemon applied to them the algebraic formulae which had been found to fit the lines of many other spectra. According to his mathematics, the unknown nebular lines attributed to nebulium lie on the same parabolic curves as the spectral lines of a helium atom which has had one electron knocked out of it. The reproduction of the nebulium lines has never yet been accomplished in the laboratory, but Prof. Lemon thinks his figures give a clue for experiments which may prove fruitful.—[*Science Service.*

BOOKS RECEIVED.

Physics, A Text-Book for Colleges, by Oscar M. Stewart, University of Missouri. viii+723 pages. 15x21½ cm. Cloth. 1924. $3.60. Ginn & Company, Boston.

Climatic Laws, by Stephen S. Visher, Indiana University. 96 pages. 15½x23½ cm. Cloth. 1924. $1.50 net. John Wiley & Sons, New York City.

Plant Anatomy, by William C. Stevens, University of Kansas. Pages xv+398. 16x23 cm. Cloth. 1924. $3.50. P. Blakiston's Son & Co., Philadelphia, Pa.

Chemistry Laboratory Manual, by Carl W. Gray and Claude W. Sandifur, Hollywood High School, Los Angeles, Cal. Pages xii+137. 19x23½ cm. Paper. 1924. $0.92. Houghton, Mifflin Co., Chicago, Ill.

Household Physics, by Walter G. Whitman, Normal School, Salem, Mass. Pages vii+437. 14x20 cm. Cloth. 1924. $1.90 net. John Wiley & Son, New York City.

Essentials of Economics, by Fred R. Fairchild, Yale University. Pages 543. 13½x19 cm. Cloth. 1924. American Book Co., Chicago, Ill.

The Story Key to Geographic Names, by O. D. Von Engelin, Cornell University; Jane M. Urquhart, Cascadilla School, Ithaca, N. Y. Pages xi+279. Cloth. 1924. D. Appleton & Co., New York City.

Laboratory Problems in Physics, by Angus L. Cavanagh, Warren G. Harding High School, Los Angeles, Cal.; Clyde M. Westcott, Hollywood High School, Los Angeles, Cal. Pages viii+124. 20x27 cm. Cloth. 1924. $0.96. Ginn & Company, Chicago, Ill.

The Financing of Public Schools in the State of Illinois, by Henry C. Morrison. Pages xiii+162. 16½x24 cm. Paper. 1924. The Macmillan Co., New York.

Plant Anatomy, by William C. Stevens, University of Kansas. Pages xv+398. 16x23 cm. Cloth. 1924. $3.50. P. Blakiston's Son & Co., Philadelphia, Pa.

Kewaunee

Superior

Laboratory Furniture

We illustrate a few only of the hundreds of designs of Laboratory Furniture, for the teaching of the sciences, shown in the latest edition of the Kewaunee Book—the most complete volume on the subject of Laboratory Furniture for Schools ever published.

It contains 416 pages, with 46 views of buildings and model installations and with some of the desks reproduced in natural colors. The book will be sent without charge, prepaid, to any instructor or official who replies, giving his position and using the stationery of the institution. Address all inquiries to the factory at Kewaunee.

Kewaunee Mfg. Co.
LABORATORY FURNITURE EXPERTS

C. G. CAMPBELL, Treas. and Gen. Man.

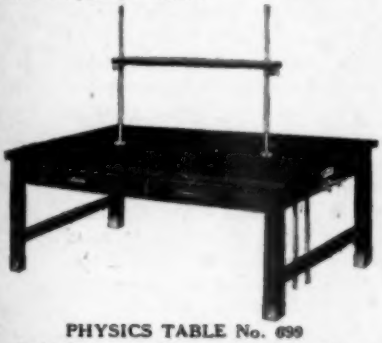
114 Lincoln St.
Kewaunee, Wis.

New York Office
70 Fifth Avenue

Offices in Principal Cities

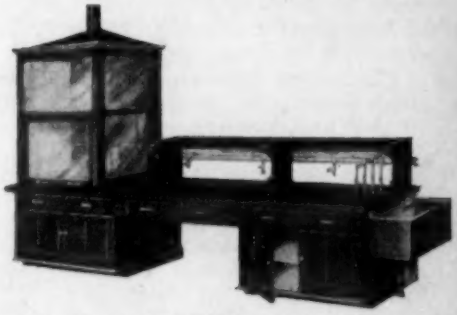
INSTRUCTOR'S DESK No. 1416
For Private Laboratory

Produced in response to an insistent demand for an absolutely private work-table. Roll top cover completely encloses.



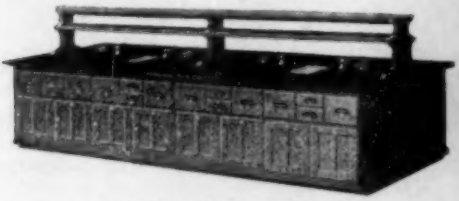
PHYSICS TABLE No. 699

A simple popular Kewaunee design, with gas connections and a wood crossbar.



CHEMICAL LABORATORY DESK AND HOOD
No. 15025

11 feet 11 inches long by 2 feet 3 inches wide. Top of birch, body of selected oak. Alberene stone sink.



CHEMICAL DESK No. 850

A good practical design at a moderate price that embodies all the essential features of the more elaborate desks.

CHEMICAL LABORATORY DESK No. 15010

A very complete desk of new design. The acme of quality and construction.

The Theory of Relativity, by Archibald Henderson, Allan Wilson Hobbs and John Wayne Lasley, Jr., University of North Carolina. Pages xiii+99. 16x23 cm. Cloth. 1924. University of North Carolina Press, Chapel Hill, North Carolina.

First Lessons in Geography, by Philip A. Knowlton. Pages 257. 17½x23½ cm. Cloth. 1924. Macmillan Co., New York City.

Physics in Everyday Life, by William D. Henderson, University of Michigan. Pages vii+566. 14½x19 cm. Cloth. 1924. Lyons & Carnahan, Chicago.

Chemistry in Everyday Life, by Frederic B. Emery, Harrison Technical High School; Elzy F. Downey, Crane Technical High School; Roscoe E. Davis, Lane Technical High School; Charles E. Boynton, Waller High School. Pages x+667+xlix. 14½x19 cm. Cloth. 1924. Lyons & Carnahan, Chicago.

Evolution or Christianity, by Wm. M. Goldsmith, Southwestern College. Pages 144. 14x19½ cm. Paper. 1924. $0.50. The Anderson Press, St. Louis, Mo.

Why the Weather, by Charles F. Brooks, Clark University. Pages xvi+310. 13x19 cm. Harcourt Brace & Co., New York City.

Laboratory Problems in Physics, by Angus L. Cavanagh, Harding High School, Los Angeles, Calif. and Clyde M. Westcott, Hollywood High School, Los Angeles, Calif. Pages viii+127. 20½x27 cm. Cloth. 1924. $0.96. Ginn & Co., Chicago, Ill.

Plane Geometry, by John O. Pyle, Harrison High School, Chicago, Ill. Pages xii+172. 13x19 cm. Paper. 1924. P. Blakiston's Son & Co., Philadelphia.

Financing of Public Schools in the State of Illinois, by Henry Morrison, University of Chicago. Pages xiii+162. 16½x24 cm. Paper. 1924. Macmillan & Co., New York City.

BOOK REVIEWS.

The Theory of Relativity, by Archibald Henderson, Allan Wilson Hobbs, John Wayne Lasley, Jr., University of North Carolina. xiii+99 pages. 16x23 cm. Cloth. 1924. University of North Carolina Press, Chapel Hill, N. C.

"The book is intended for the mathematical student who is taking up the Theory of Relativity, and may be used without reference to any other work. It embodies a survey of the Historical Background of Relativity, a state of the mathematical essentials of special and the general relativity theories, and a treatment of the subject of the curvatures of manifolds." The equations are printed in a most remarkable and clearly defined manner. Ten-point type is used. Major paragraphs begin with boldfaced type. Chapter four consists of an investigation of a treatment of curvatures of various types, and to exhibit the interconnection of these, particularly as related to the subject of curvature and general relativity. a bibliography is given in the appendix. The book lacks the general index, although the table of contents may be used as such.

C. H. S.

Eminent American Chemists, a portfolio of portraits of the most distinguished Americans in the field of chemistry from the earliest days of the Republic to the present, together with short sketches of the work of each. Compiled and edited by D. H. Killeffer, Associate Editor of Industrial and Engineering Chemistry, Secretary of the New York Section of the American Chemical Society. First edition.

School Science and Mathematics

Member of the Educational Press Association of America

No Numbers Published for JULY, AUGUST and SEPTEMBER.

PRICE. The subscription price is Two Dollars and Fifty Cents a year, if paid in advance; at the rate 30 cents a copy for less than a half year; single copies 30 cents

ALL REMITTANCES should be made payable to the order of **School Science and Mathematics. Remittances should be made by Post Office Money Order, Express Order, or Bank Draft.** If personal checks are sent, please add ten cents for collection.

SCHOOL SCIENCE AND MATHEMATICS is the "official organ" of the following associations: The Central Association of Science and Mathematics Teachers, Eastern Association of Physics Teachers, The Physics Club of New York, Missouri Society of Teachers of Mathematics and Science, Science and Mathematics Section of the Oregon State Teachers Association, Saskatchewan Science and Mathematics Teachers Association, Southern Pacific Science and Mathematics Teachers Association, Kansas Association of Mathematics Teachers, New York State Science Teachers Association, New Jersey Science Teachers Association, New England Chemistry Teachers Association, Langley Association of Science Teachers.

POSTAGE IS PREPAID for all subscriptions in the United States and Mexico. For Canada add 25 cents for postage. For all other countries in the Postal Union, add 50 cents.

CHANGE OF ADDRESS. Subscribers should send notice of any change of address before the 12th of each month; otherwise they are held responsible for magazine, sent to their former address, and no duplicate copies will be sent except on payment of 30 cents for each copy. Send notices to School Science and Mathematics, Mount Morris, Ill., or 2055 East 72nd Place, Chicago.

MANUSCRIPTS. Contributions on Science and Mathematics Teaching are invited. Articles must be written on one side of the sheet only. All illustrations must be drawn or written in jet black on a separate sheet of manuscript. Contributors are requested to write scientific and proper names with particular care. Manuscripts should be sent to the Editor of **School Science and Mathematics, 5517 Cornell Ave., Chicago,** or to the proper departmental Editor. Books and pamphlets for review should be sent to the Editor. To insure insertion in any number, manuscript must be in the editor's *possession not later than the 20th of the second month before* publication.

MISSING NUMBERS will be replaced *free* only when claim is made within thirty days after receipt of the number following.

REPRINTS, if desired, must be ordered in advance of publication. Reprints of leading articles will be printed as ordered, the actual cost (with cover, if desired) to be paid for by the author. Reprints *must* be *paid* for when ordered. The table below shows the *approximate* cost of reprints consisting of plain text or text with line engravings. The actual cost may vary from the figures given and will depend upon the amount of work in re-making the pages into forms, press work, paper, printing, etc.

Number of Copies	100	Extra Hundreds	Number of Copies	100	Extra Hundred
2 pages	$1.65	$0.30	16 pages	$7.35	$1.50
4 pages	2.30	.50	20 pages	9.60	1.75
8 pages	4.75	.90	Cover, extra	3.10	.50
12 pages	6.75	1.35			

SCHOOL SCIENCE AND MATHEMATICS

PUBLICATION OFFICE **MOUNT MORRIS, ILLINOIS**

Business Office, 2055 72nd Place, Chicago

Editorial Office, 5517 Cornell Ave., Chicago

Please mention School Science and Mathematics when answering Advertisements

Thirty-three portraits suitable for framing. Put up in an attractive loose leaf binding. Size of portraits, four and one-fourth by six inches with wide margins for framing. Done on heavy paper. The portraits bear autographs of the subjects and are interleaved with short sketches of the accomplishments of each man. A limited edition 1924 published privately by the editor, D. H. Killeffer, 19 E. 24th St., New York City. The names of the men follow—L. H. Baekeland, W. S. Bancroft, B. B. Boltwood, J. C. Booth, C. F. Chandler, R. H. Chittenden, F. W. Clarke, F. G. Cottrell, Josiah P. Cooke, E. C. Franklin, J. Willard Gibbs, Moses Gomberg, Robert Hare, W. F. Hillebrand, T. Sterry Hunt, Irving Langmuir, G. N. Lewis, J. W. Mallett, E. W. Morley, A. A. Noyes, W. A. Noyes, Joseph Priestley, Ira Remsen, T. W. Richards, Count Rumford, Benjamin Silliman, Sr., Edgar F. Smith, J. Lawrence Smith, Julius Stieglitz, Donald D. Van Slyke, W. R. Whitney, H. W. Wiley. The price of the portfolio is $6. Whether as a reference library book in its present form or as a source of portraits to be framed and hung in the chemistry rooms this portfolio is extremely desirable for every high school and college chemistry department.

F. B. W.

Elements of General Science, by Otis William Caldwell, Ph. D., Professor of Education, Director of the Lincoln School, and Director in the Institute of Educational Research of Teachers College, Columbia University, and William Lewis Eikenberry, Professor and Head of the Science Department, East Stroudsburg State Normal School, Pennsylvania. New edition. pp. xiii+455. 15x20x2.5 cm. Illustrated. Cloth. 1914-1918-1924. $1.60. Ginn & Co.

This new edition of a well known text in general science, while retaining the general plan of the former editions has much added material. The topics of gas and electric engines, radio, hygiene and health and studies of vitamins may be mentioned as among the newer subjects treated. Seventy-eight new illustrations have been added. The text has been wholly rewritten with a view to using only an eighth grade vocabulary.

F. B. W.

Climatic Laws, by Stephen S. Visher, Indiana University. 96 pages. 15½x23½ cm. Cloth. 1924. $1.50 net. John Wiley & Sons, New York City.

An attempt has been made here in lieu of a better title to call the text The Laws of Climate which is a very excellent idea. The object of this book is to point out and explain these relations which correspond insofar as the nature of the subject permits it, the laws of other sciences. It is a text that will be helpful to everyone interested in the weather. The relative humidity, condensation, precipitation, seasonable distribution, steadiness of winds, doings of topography and many other subjects are clearly discussed.

C. H. S.

First Lessons in Geography, by Philip A. Knowlton. vi+257 pages. 17½ +23½ cm. Cloth. 1914. The Macmillan Co., New York City.

This text-book of geography is made so simple but at the same time so true to nature and life that any pupil who can read ordinary English can understand without any further explanation. It is a marvelous book for the youngster. The cuts, of which there are many, are largely half-tones, and they have been selected with care so that they bring out the very fact that they are illustrating.

It is printed in twelve point type with plenty of spacing, making the book attractive and easy to read. Much emphasis has been laid upon

GOOD BOOKS *for* 1924-1925

Visual Education
Edited by FRANK N. FREEMAN

Tests the claims of visual education, and weighs the possibilities of these new methods. $3.50, postpaid $3.70.

Law and Freedom in the School
By GEORGE A. COE

A critique of our present educational methods and an analysis of the part played by law in the project method. $1.75, postpaid $1.85.

A Naturalist in the Great Lakes Region
By ELLIOT R. DOWNING

It describes the creatures of the out-of-doors as a collection of related objects, each of which has a definite place in the world.

$2.50 and $3.50, postage 10 cents extra.

The Anatomy of Woody Plants
By E. C. JEFFREY

The standard work in this field by the leading authority on the anatomy of plants. $4.75, postpaid $4.87.

The Electron (*Revised*)
By ROBERT ANDREWS MILLIKAN

A standard work brought completely up-to-date, and including even the Compton effect.

$1.75, postpaid $1.85.

Methods in Plant Histology (*Revised*)
By C. J. CHAMBERLAIN

Practically a new book, bringing up to date the methods for preparing all kinds of plant structures for microscopic study.

$3.25, postpaid $3.37.

Algebras and Their Arithmetics
By LEONARD E. DICKSON

A far-reaching theory of the arithmetic of any rational algebra.

$2.25, postpaid $2.35.

Our Physical World
By ELLIOT R. DOWNING

A source book of physical nature-study to be included in the new University of Chicago School Science Series. It provides the teacher with the subject-matter of physical science organized about toys and familiar home appliances. It is rich in material that will enable the teacher to present the subject in better perspective, and that will help her deal with the problems which experience has shown are most frequently encountered.

$2.50 and $3.50, postage 10 cents extra.

Our Living World
By ELLIOT R. DOWNING

A source book of biological nature-study to be included in the new University of Chicago School Science Series. This work is simple, non-technical, and vivid in its presentation of common animals, reptiles, insects, birds, trees, seeds, and flowers, and it reveals their significance and wonder. In addition to its description of common plants and animals, it gives some discussion of their environment and economic value.

$2.50 and $3.50, postage 10 cents extra.

General Cytology
Edited by E. V. COWDRY

The first co-operative and comprehensive attempt by specialists in research fields to state in general terms what is known or conjectured regarding the principles that govern cellular structure and function. It is the first volume to present the data concerning the cell that are fundamental not only to the sciences of botany and zoology, but to physiology and pathology as well.

$7.50, postpaid $7.75.

THE UNIVERSITY OF CHICAGO PRESS
5862 Ellis Avenue **Chicago, Illinois**

Industrial Geography. The sentence structure is splendid and the diction such that children will have no difficulty in understanding it. The material for the illustrations has been well selected. It is a book that all teachers of Geography in the grades should have in their possession.

C. H. S.

Physics, A Text-Book for Colleges, by Oscar M. Stewart, University of Missouri. viii+723 pages. 15x21½ cm. Cloth. 1924. $3.60. Ginn and Company, Boston.

A splendid book written by a splendid teacher for those students primarily in college who have not had much training in mathematics. It is a book especially prepared for students who expect to specialize in agriculture or medicine, or for those who are taking physics as a part og a general course in arts. The illustrations, of which there are 466, have been chosen with care so that they will illustrate clearly the point that they are intended to bring out.

The introduction of modern theories and methods makes the book interesting and vital. The latest notions concerning the atom and the electron are clearly discussed, as are also the method of measuring ex-rays and the uses of thermiomic tubes.

The author has used pedagogical methods in presenting the subject matter. There are forty-eight chapters with the characteristic headings. Major paragraphs all begin with bold-faced type. Each chapter closes with a fine selection of practical problems bearing upon the work discussed in that chapter. The book, as is customary with this publishing house's texts, is mechanically well made and will stand hard usage. It is printed on a fine quality of paper, and is a book that should be in the hands of every instructor in college physics.

C. H. S.

Beginnings in Educational Measurement, by Edward A. Lincoln, Harvard University. 151 pages. 13x19½ cm. Cloth. 1924. J. P. Lippincott Co., Philadelphia.

The demand on the part of the educators to know what the pupil is worth in order that he may be properly trained or given those subjects for which he is best adapted has led the author to produce this very interesting text. It is a book that is full of meat from beginning to end for people who are really teachers, and who are intensely interested in their pupils, who have a desire to have them given those subjects in which they stand in most need.

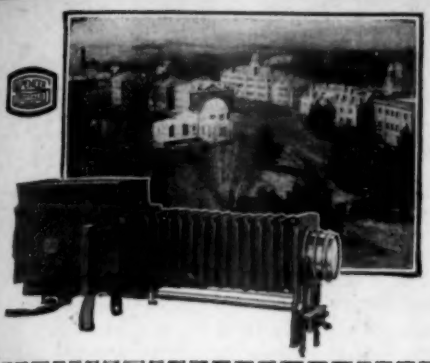
The book deals with class experiences and associations with the pupils. It is printed on unglazed paper in ten-point type. Major paragraphs begin with bold-faced type, and the bold-face is really the key to the discussion which follows. There are a number of appendices with many suggestions bearing upon this line of work.

C. H. S.

Heat, by L. R. Smith, Wm. L. Dickinson High School, Jersey City, N. J. xi+283 pages. 12½x19 cm. Cloth. 1924. $2.00 net. McGraw-Hill Book Co., New York City.

This is one of a series of text-books published on the general title of Industrial Physics. This book really comes from an experience of this well-known instructor in physics. It comes from the notes used by him in his classes.

Much care has been used to emphasize the underlying principles of heat as well as the practical applications. Each chapter closes with a list of suitable questions for study and review, and there are enough of these questions of a mathematical nature to keep the subject of mathematics fresh in the student's mind.



Side by Side with the Blackboards at Dartmouth

Working side by side with the blackboards at Dartmouth, Daylight Projection with the Spencer Delineascope and Trans-Lux Daylight Screen is a new force stimulating mental processes for both professors and under-grads.

The Spencer Delineascope and Trans-Lux Screen illustrate any subject—at any time in lecture room or laboratory—and in broad daylight.

Send the coupon for the story of Daylight Projection.

Spencer Lens Company,
Buffalo, N. Y.

Please send me the story of Daylight Projection and its value in teaching.

Name.....

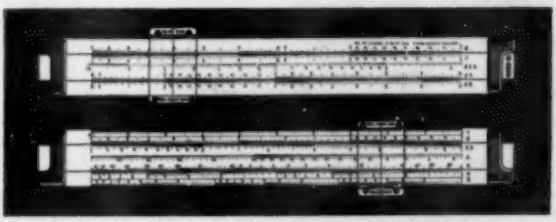
Address.....

Institution.....

SPENCER LENS COMPANY

442 Niagara St. **Buffalo, N. Y.**

The Slide Rule in Trigonometry



The use of the Slide Rule as a check in Trigonometry is now regularly taught in colleges and high schools. Our manual makes self-instruction easy for teacher and student. Write for descriptive circular of our slide rules and information about our large **Demonstrating Slide Rule** for use in the class room.

KEUFFEL & ESSER CO.

NEW YORK, 127 Fulton Street, General Office and Factories, **HOBOKEN, N. J.**

CHICAGO 516-20 S. Dearborn St. **ST. LOUIS** 817 Locust St. **SAN FRANCISCO** 30-34 Second St. **MONTREAL** 5 Notre Dame St. W.

Drawing Materials, Mathematical and Surveying Instruments, Measuring Tapes

The illustrations, of which there are 276, have been selected with care. Most of them are new. Mechanically the book is well made. It is printed in ten-point type on good stock. It is a book which the reviewer can recommend to any instructor in physics who wishes help in his instruction in heat.

C. H. S.

Junior High School Curricula, by Harlan C. Hines, University of Cincinnati. xii+188 pages. 13x19½ cm. Cloth. 1924. $1.20. The Macmillan Co., New York City.

In this day and age, when the Junior High School is on the battle-field in many localities for its real existence, the appearance of this book is indeed very timely. The hue and cry that is now being raised against Junior High Schools, especially in Chicago, is due to a lack of knowledge for which these schools stand. The appearance of this book, if studied by parents and teachers, will do everything to dispel the antipathy which now exists. Many people have been puzzled over what should be taught and how it should be presented, and what should go in the training of the teacher who will make a success in this type of school. The book has been prepared quite largely for supplying answers to such questions, and is a text that should be in the hands of all teachers in Junior High Schools.

C. H. S.

Essentials of Economics, by Fred R. Fairchild, Yale University. Pages 543. 13½x19 cm. Cloth. 1924. American Book Co., Chicago, Ill.

Economics usually brings to the student his first knowledge of the social sciences, and if this book accomplishes nothing more than creating an interest in the social sciences it surely has accomplished one of its purposes.

In the study of Economics, the experimental method is as a general thing not available. Although there are some simple experiments which bring out fundamental principles, by application it prepares an interest in the beginner to the study of the physical and the biological sciences. Economics, from the nature of the case, suffers more than the ordinary sciences, because of the fact that many of the terms with which it deals, are in everyday use by everybody.

The method in this book is strictly scientific. There is no propaganda, no attempt to show things as they ought to be. The book will cause the student to think and work out for himself the cause and effect.

There are found problems at the end of each chapter which can be used to fix the principle study in the chapter to which they are appended. There is a list of reference books at the end of each chapter.

The paper is of good stock, not highly calendared, thus making it easy to read. It is printed in ten-point type with the key sentence to each paragraph in bold-faced type. The book is mechanically well made, and will stand strong usage.

The reviewer recommends that all persons interested in economics secure a copy and study it.

C. H. S.

The Story Key to Geographic Names, by O. D. Von Engelin, Cornell University and Jane M. Urquhart, Cascadilla School, Ithaca, N. Y. Pages xi+279. Cloth. 1924. D. Appleton and Co., New York City.

A neat book in its purpose. At the same time valuable. A book that ought to have been written ten years ago. It is full of meat and valuable information. A book that all of the older generation ought to have read years and years ago. But for the young generation, there is no excuse

Varsity Automatically Controlled Electrically Heated Ovens

For Drying Operations and Moisture Determinations

Both regulator and heating plate are very substantially constructed so as to give permanent service.

The single walled small sized oven, 10"x10"x12" i. d., has been regularly used for the testing of wood used in aeroplane manufacture, price—$50.00.

The double walled oven, small size, is still more satisfactory for general laboratory work, price—$60.00.

Write for Bulletin.

EIMER & AMEND

Established 1851

Headquarters for Laboratory Apparatus and Chemical Reagents

New York, N. Y.

Third Ave., 18th to 19th Street

Pittsburgh, Pa. Agent, 4048 Franklin Rd., N. S.

The Ideal Course in Mathematics for 7th, 8th, and 9th School Years

is embodied in the series of three text books by Raleigh Schorling and John R. Clark:

Modern Mathematics:	**Seventh School Year**	**$ .88**
Modern Mathematics:	**Eighth School Year**	**.88**
Modern Algebra:	**Ninth School Year**	**1.36**

These books are not untried. Before publication they were printed in experimental editions, taught by over 150 teachers, and revised again and again on the basis of results obtained and suggestions for improvement.

Now, within seven months of publication, a quarter of a million copies have been manufactured to fill orders, which is further evidence that the series meets the demands for a practical modern course for junior high school grades.

Write now for the free booklet, "Vitalizing Mathematics."

World Book Company

Yonkers-on-Hudson, New York **2126 Prairie Avenue, Chicago**

for them not knowing what geographic names mean and their derivations. It is a book of fourteen chapters, and covers the entire world. Of course, the major part of the book is devoted to geographic names of North America.

The particular word being described is printed in bold-faced type. The paper stock is good, not highly calendared. There is a complete index of names and terms, consisting of twelve three-column pages. Also, there appears an index of seven pages. It is a valuable book.

C. H. S.

College Manual of Optics, by Lloyd Wm. Taylor, University of Chicago Pages viii+236 14½x21 cm. Cloth. 1924. $2.80. Ginn and Company, Chicago, Ill.

A book which any instructor in physical optics will be glad to welcome. It is not a manual nor is it a text-book, but is a combination of the two. Undoubtedly, many of the points discussed have originated at the University of Chicago which is noted for its work in physical optics. In the laboratory end of the book, several alternative methods for carrying out some experiments are suggested. This is a good feature.

The information presented in this book has been drawn for any field capable of contributing to the work which he is trying to advance. It is splendidly written, the diction being as near perfect as work of this kind can be. The cuts are splendidly made. The paper is not too glossy. The body of the work is printed in ten-point type. It is a book that all teachers of optics should possess.

C. H. S.

Elements of Electrical Engineering, by George D. Shepardson, Cornell University. Pages viii+335. 15x22½ cm. Cloth. 1924. The Macmillan Co., New York.

This volume has been prepared very largely as an introductory text-book in electrical engineering for technical schools and colleges. It includes a short discussion of the fundamental principles of the more important types of machines for both kinds of electrical currents. The emphasis, as the reader will notice, is more upon the practical phase of the subject than on the mathematical side. For the sake of the reader whose mathematics are not very fresh in his mind, explanations are given.

A text of this size is not expected to contain material enough for a complete training in this line of work, but there is enough said to fix in a person's mind essential facts.

The book is built with the expectation that the experimental work in the laboratory will be done as is outlined in the appendix A on page 307. It is essential that the student do this laboratory work in order to fix in his mind the ideas of electrical engineering. At the end of each chapter there is a list of subjects for further study. These are very helpful not only to the student but especially to the teacher.

There are twenty-one chapters, the subjects of which cover the high points in electrical engineering. Major paragraphs begin with bold-faced type. There are 121 drawings and half-tones. There are eight appendices giving bibliography, electrical symbols, and several pages devoted to electrical chronology. Mechanically the book is well made, good quality of paper being used.

C. H. S.

Our Physical World, by Elliot R. Downing, University of Chicago. Pages xviii+355. 14½x20 cm. Cloth. 1924. $3.50. University of Chicago Press.

One of the finest books that has recently come from the press with reference to our physical world is this text. Somebody was forced to

PETERSON LABORATORY FURNITURE

Instructor's Table No. 1205

Building Satisfaction Into Laboratory Equipment

Since 1890 Leonard Peterson has been building satisfaction into Laboratory Furniture for schools and colleges.

From the very beginning we have strictly maintained the policy of putting quality of the highest order into every article produced in our factory. What is the result? Peterson Equipment is being used in leading institutions from the Atlantic to the Pacific.

Leonard Peterson is one of the oldest manufacturers of Laboratory Furniture and is today the most progressive. The installation of Peterson Laboratory Furniture insures complete and lasting satisfaction.

Send for Catalog No. 14-D. It shows a complete line of fine laboratory and office furniture for industrial plants, hospitals and educational institutions.

LEONARD PETERSON & CO., INC.

Manufacturers of Guaranteed Laboratory Furniture

OFFICE AND FACTORY

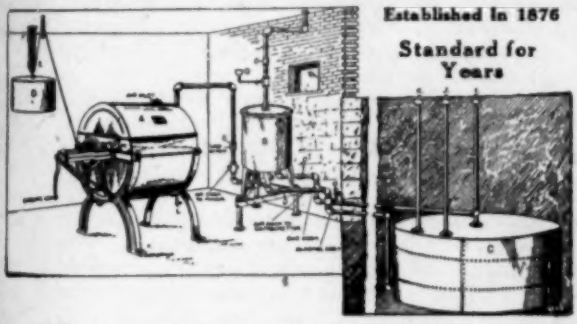
1222-34 Fullerton Avenue — Chicago, Ill.

New York Sales Office: Knickerbocker Bldg., 42nd and Broadway

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be had for 30 cents a single copy. The Mathematical Supplements for 15 cents a copy.

In sets the prices are, postpaid:

School Mathematics and Supplements, Vol. I, five numbers	$1.00
School Science, Vol. I, seven numbers	5.50
School Science, Vols. II, 7 numbers	5.00
School Science, Vol. 3, eight numbers	5.50
School Science, Vol. IV, three numbers	.75
School Science and Mathematics, Vols. V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI and XVII, each	2.50
School Science and Mathematics, Vols. XVIII, XIX, XX, XXI, XXII, and XXIII, each	2.50



Established In 1876

Standard for Years

This Machine Will Produce *Automatically*

GAS

For your laboratories, Domestic Science Department and for lighting.

• • •

In use in hundreds of educational institutions throughout the country.

Write to us for a list of colleges and high schools using our machine.
Illustrated Catalogue Will be Sent on Request.

MATTHEWS GAS MACHINE CO.

6 E. Lake Street — CHICAGO, ILLINOIS

produce a text which would, in plain language, concisely stated, be able to tell the earlier generation especially something about the phycisal laws which are continually engaging our education.

No one is more thoroughly competent to produce an edition of this kind than the author of this particular book.

There has been a steady increase in the demand for science instruction in our high schools, especially in the grammar schools the demand has been something like the waves in the ocean—up and down. This spasmodic condition has not been produced by the intermittent desire on the part of the school officials but more particularly on the lack of good teachers of the subject. When a knowledge of the sciences is only such as can be secured from what is accorded from high school, there is not much probability that very effective work will be done by such people, but when it becomes organized and competent teachers are secured in the grades, then there will be a continual demand for subject matter such as is given in this book.

The fundamental principle of this book has been to organize the subject matter of grammar grade physical science about those things which are familiar to the youngsters who have not passed up into high school.

Mechanically the book is splendidly made. Many of the cuts, of which there are 195, have been selected especially for this work. School officials about to introduce this kind of work into their grammar schools cannot do better than to adopt this text.

C. H. S.

Household Physics, by Walter G. Whitman, Normal School, Salem, Mass. Pages vii+437. 14x20 cm. Cloth. 1924. $1.90 net. John Wiley & Son, New York City.

This book, as its name implies, is a study of household physics. It is devoted almost entirely to descriptions of household apparatus or apparatus kindred to the household. It is a text that this reviewer can recommend to any school board that is looking for a book to be used by a class of girls.

The cuts, of which there are 329, are made almost entirely for use in this particular volume. The drawings are splendidly executed, and surely show the principle that they are endeavoring to illustrate.

The diction is splendid. Major paragraphs all begin with bold-faced type, this type being the key to the matter discussed in that paragraph. Each chapter closes with a list of problems, a summary of the work brought out in that chapter, and a list of reference books.

It seems a little strange to review a text in physics where the mechanics of it are reduced to such a minimum as found in this book, but altogether it is a wise arrangement of matter. Mechanically the book is splendidly made, printed upon paper that is not too glossy.

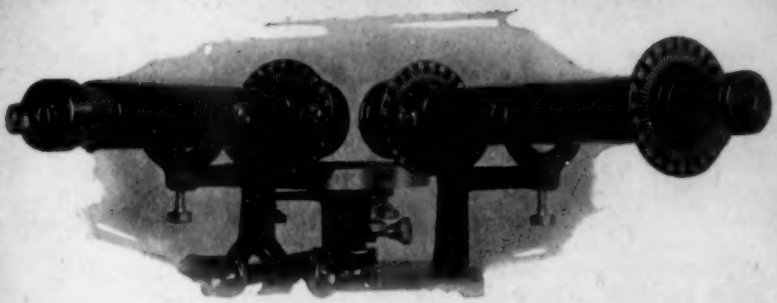
C. H. S.

Laboratory Physics, by E. H. Johnson, Keynon College. Pages viii+322. Cloth. 1924. Harcourt, Brace, and Company, New York City.

This is a valuable work and is one of the newest books of high quality in secondary school laboratory work.

There are in the text fifty-eight experiments, some of which are not found in secondary laboratory texts. All of them are well written. The diction is splendid. The drawings are perfect and altogether presented in such a way that the student will have no trouble in understanding what he has to do.

If any criticism is to be offered, it is to the effect that the descriptions are too explicit, not giving the pupil as much material as he should have to think about the results.



SIMPLE POLARIZING ATTACHMENT

For Gaertner College Spectrometer

Recommended for studying Fresnel's laws of refraction, elliptical polarization by reflection and by transmission through crystals, etc. The attachment is made to fit our L 101 Spectrometer, but it can be fitted to any other small spectrometer at a nominal additional cost.

Two circles carrying rotable 10 mm nicols fit over the telescope and collimator objectives. A third circle at the eye end and fits in the place of the usual adapter with cross hairs and carries a special Ramsden eyepiece with a nicol between the lenses. The circles are divided to 5 degrees and permit estimating to single degrees. The nicols may be rotated independently of the circle for adjustment of zero.

L 101d. Polarizing Attachment for L 101 Spectrometer, $60.00

Bulletin No. 101 on Spectrometers and Accessories will be mailed on request.

PHYSICAL APPARATUS

For Elementary Laboratory Work

Designed for Use with the Millikan, Gale and Bishop Course

GAERTNER APPARATUS for this course has been recognized as superior ever since its introduction. Many pieces of the apparatus were designed, in conjunction with the authors, by our President, Mr. Wm. Gaertner, himself an expert scientific instrument maker of world-wide repute.

Write for Catalog H-D:1923

The Gaertner Scientific Corporation

Successor to Wm. Gaertner & Co.

1201 Wrightwood Avenue **Chicago, U. S. A.**

There are a number of appendices, containing many things which can be used in connection with the experiments. There is a splendid index, double-paged. Mechanically, the book is well made, printed on paper that is not highly calendared, and in every way the reviewer recommends that every secondary school teacher possesses himself with a copy.

C. H. S.

Problems in General Physics, for College Course, by Morton Massius, Worcester Polytechnic Institute. Pages viii+154. Cloth. 1924. $2.00. Blakiston's Son and Company, Philadelphia.

A magnificent little book intended to supplement "A Text Book of Physics by Duff." It is largely for college pupils and contains problems covering all the divisions of physics. They have been selected with great care and are practical in every respect.

There are in the text 1008. They are divided according to the usual division of physics. There is an appendix of trigometrical tables, complete enough for the solution of any of the problems in the text. All instructors in college physics should possess themselves of a copy of the book.

C. H. S.

Our Faith in Education, by Henry Suzzallo, University of Washington. 108 pages. 12½x18½ cm. Cloth. 1924. J. P. Lippincott Co., Philadelphia.

This little book has been prepared by the author from many suggestions which have been received by teachers and others. The thoughts have been uttered at various places widely separated, at different times, spreading over a period of many years.

The author has used many trite expressions in his addresses in many places. They have all been loaded with the idea that people are becoming more and more filled with the idea of faith and confidence in education. The author's statements have been such as to strengthen the layman's mind and impress him with the value of education for everyone.

There are many people who think that education is being overdone, but a knowledge of the thoughts contained in this little book will convert anyone except the confirmed bigot to the fact that the more education our citizens have the better will be our citizenship.

C. H. S.

Physics in Everyday Life, by Wm. D. Henderson, University of Michigan. Pages vii+566. 14½x19 cm. Cloth. 1924. Lyons & Carnahan, Chicago.

It is with pleasure that the reviewer of this text attempts to give a short description of this book in secondary school physics. It has been written by a past master in physics, one who understands the subject from beginning to end. It is written in such a manner that the student cannot help becoming interested in the subject matter. There are many recent discoveries in physics that are presented in this text. The diction is splendid.

Most of the cuts, of which there are 599, were sepecially made for this work. Major paragraphs all begin with bold-faced type. Scattered throughout the text are many practical problems selected for the truth that they are to teach.

The book has been prepared with the idea of impressing upon the pupil's mind the fact that the subject is not a mass of abstract laws but as a science which touches life on every hand. School boards and those in authority will make no mistake in selecting this book as their text. It is well-bound and printed in ten-point type on a high quality of paper, and is in every way intended to give good service.

C. H. S.